

Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.



691Rp
of 2

TWENTY-FIFTH ANNUAL REPORT

of

Pasture Research

in the

Northeastern United States
University Park, Pennsylvania

1961

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY

OCT 29 1964

CURRENT SERIAL RECORDS

FOR ADMINISTRATIVE USE ONLY



1961

Twenty-fifth Annual Report

of

Pasture Research

in the

Northeastern United States

U. S. Regional Pasture Research Laboratory
University Park, Pennsylvania
Forage and Range Research Branch
Crops Research Division,

Northeast Branch
Soil and Water Conservation Research Division,
and
Grain and Forage Insects Research Branch
Entomology Research Division
of the
Agricultural Research Service
U. S. Department of Agriculture

and

The Agricultural Experiment Stations
of the
Twelve Northeastern States
Cooperating

- - - - -

Copies of this report were sent to all organizations involved in the development of the present pasture research program in the twelve Northeastern States and in addition to some institutions outside the Region where grassland research is a major interest.

For Administrative Use Only

B.

THE LABORATORY STAFF

V. G. Sprague	Plant Physiologist in Charge
Lois L. Smith	Secretary
N. Dawn Neidigh	Typist

Research Scientists

J. H. Graham	Plant Pathology
Helen D. Hill	Grass Cytogenetics
A. W. Hovin	Legume Genetics and Cytogenetics and Grass Cytogenetics
R. C. Newton	Entomology
V. G. Sprague	Physiology and Microclimatology
J. T. Sullivan	Plant Chemistry
S. R. Wilkinson	Soils

Assistants

C. F. Gross	Soils
G. A. Motter	Agronomy and Physiology
E. S. Titlar	Plant Chemistry
K. E. Zeiders	Plant Pathology

Part-time Assistants

Donald Burdick	Plant Chemistry
Gerald E. Carlson	Physiology

COLLABORATORS

R. B. Alderfer, New Jersey	W. H. Mitchell, Delaware
G. L. Byers, New Hampshire	G. G. Pohlman, West Virginia
W. G. Colby, Massachusetts	J. Thomas Reid, New York
H. B. Couch, Pennsylvania	A. L. Steinhauer, Maryland
J. R. Guttay, Connecticut	R. C. Wakefield, Rhode Island
C. M. Milne, Maine	G. M. Wood, Vermont

H. R. Fortmann, Penna. - Representative of Northeastern Directors

* * * * *

* This annual report of pasture research in the twelve *
* Northeastern States is a progress report and as such *
* may contain statements which may or may not be veri- *
* fied by subsequent experiments. The fact that any *
* statement has been made herein does not constitute *
* publication. For this reason citation to particular *
* statements in the report should not be published un- *
* less permission has been granted by the author. *
* *
* The report is prepared primarily for the official use *
* of forage crop research workers in the Region and *
* since it is reproduced in limited numbers, it is not *
* available for general distribution to individuals out- *
* side the Region. *
* * * * *

TABLE OF CONTENTS

	Page
Introduction -----	1
Personnel changes at the Pasture Laboratory -----	1
Collaborators' conference -----	1
Research at the Pasture Laboratory	
Genetics, pathology and entomology -----	2
Alfalfa -----	2
Creeping-rooted -----	2
Selection for disease resistance -----	2
Rapid screening for resistance to <u>Corynebacterium</u> <u>insidiosum</u> -----	3
Wilt resistance in DuPuits -----	3
Crown and root rot -----	4
Combining disease and insect resistance -----	4
Survey for weevil in Pennsylvania -----	4
Coumestrol at different locations -----	4
Clovers -----	5
Interspecific hybridization and cytogenetics -----	5
Selection for persistence in red clover -----	5
Effect of fungicides and insecticides -----	6
Factors affecting internal breakdown -----	6
Disease resistance as affected by fertilization -----	7
Relationship between <u>Calomycterus setarius</u> and <u>Fusarium</u> -----	7
Clover root curculio flight period -----	7
<u>Leptosphaerulina</u> (<u>Pseudoplea</u>) -----	7
Orchardgrass -----	8
Breeding -----	8
Male-sterility -----	8
Spittlebug injury -----	8
<u>Lolium-Festuca</u> hybrids -----	9
Selection for fertility -----	9
Cytogenetics of Kentucky hybrids -----	9
Bromegrass -----	10
Selection for disease resistance -----	10
<u>Stagonospora bromi</u> -----	10
Insects -----	10
Biochemistry, physiology and soils -----	11
Carbohydrate studies on grasses(In cooperation with the New Hampshire Station) -----	11
Measurement of feeding value by chemical analysis -----	12
Preservation of fresh forage -----	13
Climate at State College -----	13
Climate studies (cooperative with 10 states in NE-29) -----	14
Legume and grass seedling establishment -----	14
Biological method of measuring reserves (cooperative with 9 states in the Northeast) -----	15
Temperature and plant growth -----	16
Physiological studies on root-spreading alfalfa -----	16

Clover in association with orchardgrass	17
Seedlings	17
Establishment in sods	17
Competition of various species and orchardgrass	18
Decaying orchardgrass roots and clover seedlings	19
Phosphorus fertilization	19
Soil and air temperatures	19
Nutrient culture techniques	20
Soil toxicity and steam sterilization	20
Seedling establishment of birdsfoot trefoil	21
Distribution of fertilizer by two methods	21

Research at Beltsville, Maryland

Leaf area vs. root reserves in regrowth	22
Grazing pressure and botanical composition	22
Nitrate accumulation and environment	23
Trefoil improvement	23
Crownvetch improvement	23

Reports of Cooperative Projects

NE-13 - The mechanization of forage crop harvesting, processing, storing and feeding	24
NEM-22 - Facilitating the marketing of seed through improved testing procedures	26
NE-24 - The nutritive evaluation of forages	28
NE-28 - Breeding and evaluation of improved varieties of forage crops adapted to the Northeast	30
NE-29 - Management and productivity of perennial grasses	32
NE-43 - Profitability of alternative forage systems for Northeast dairy farms	33

Research at State Stations

Connecticut (Storrs)

Forage experiments	34
Weed control	36
Herbicides in management	36

Delaware

Control of insects	37
Fertilization, cutting heights, and irrigation vs. yields of orchardgrass	37
Alfalfa hay production	38
Nutritive value of sorghum silage	38

Maine

Management of alfalfa mixtures	39
Topdressed potassium on alfalfa and timothy	39
Chemical composition of roughages	40
Harvesting high yielding forage	40

Maryland

Variety evaluation	41
Red clover breeding	42
Root and crown rot of alfalfa	42
Ladino clover breeding disease and insect investigations	42
Insects	42
Fertilizer for alfalfa	43
Nitrogen source, number of applications and recovery of Bermudagrass	44
Irrigation and fertilization of five forage species	44
Nitrogen rates and clipping frequency of Bermudagrass	45
Orchardgrass, response to sources of nitrogen and time of application	46
Bermudagrass, response to rates of potassium and nitrogen	46
Orchardgrass, response to rates of potassium and nitrogen	47
Legume-grass mixtures, response to differential nitrogen fertilization	47
Sod seeding	48
Soil temperature and forage growth	49
Clipping heights, frequency of harvest, response of Bermudagrass	49
Management of summer annuals	49
Evaluation of perennial pastures for lactating dairy cows	50
Evaluation of summer annual pastures for lactating dairy cows	50
Grass and legume combinations for beef production	51

Massachusetts

Forage crop insects	51
Orchardgrass and time and height of clipping and rates of nitrogen	55

New Hampshire

Improvement of white clover	56
Improvement of brome grass, red clover and alfalfa	57
Forage systems	58

New Jersey

Root rot in alfalfa	58
Cutting management of summer annual grasses	59
Bermudagrass fertilization	60
Alfalfa and percent calcium-saturation influence on exchange complex and fertilization	61
Grass yields and heavy nitrogen fertilization	61
Grass fertilization	62
Pasture renovation	62
Nitrogen-fertilized grass vs. alfalfa in milk production	64
Kentucky bluegrasses for grazing	64
Silage	65

New York (Cornell)

Breeding and cytogenetics	66
Breeding and evaluation of improved varieties	67
Breeding and strain evaluation for feeding value, yield and seasonal distribution	68
Forage diseases	70
Date of cutting, fertilization and irrigation vs. digestibility and intake by ruminants	71

Management and productivity of perennial grasses -----	72
Birdsfoot trefoil and insects -----	72
Forage insects -----	73
Insecticide residues in milk and eggs -----	74
Insecticide residues on crops -----	75
Alfalfa and birdsfoot trefoil adaptation to soil moisture and aeration -----	75
Forage and utilization by livestock -----	77
Nutritional losses during harvesting and storage of silage -----	78
<u>Pennsylvania</u>	
Genetics and improvement of perennial legumes -----	78
Cytogenetics and interspecific hybrids -----	79
Fertilization of grasslands -----	80
Genetics and improvement of grasses -----	80
Productivity of fertilized grasses -----	81
Birdsfoot trefoil, establishment and maintenance -----	81
Forage utilization by beef cattle -----	83
Evaluation of sorghum, Sudangrass and millets for feed production -----	84
<u>Rhode Island</u>	
Forage crop establishment -----	85
Pests and their control -----	85
Fertilizers for grass and grass-legume mixtures -----	85
<u>Vermont</u>	
Lotus species -----	86
<u>Sclerotinia trifoliorum</u> , sexual stage production under thermoperiods and light energy -----	86
Insects, importance and control -----	87
<u>Trifolium medium</u> L. -----	87
Agronomic evaluation of lines and hybrids of birdsfoot trefoil -----	87
Sheep grazing of birdsfoot trefoil -----	88
Nitrogen studies with grass -----	88
<u>West Virginia</u>	
Root rots, losses of legumes -----	89
Diseases of grasses -----	89
Alfalfa under different climates and influence of fall cutting -----	89
Evaluation of Sudangrass for pasture -----	90
Alfalfa and rate of K fertilizer -----	91
Sudangrass fertility and management -----	91
Physiological and biochemical studies of cold resistance -----	92
Grain replacement values of hays cut at various dates -----	92
Hay fed to yearling cattle in the open by three methods -----	93
Rumen biopsy technique -----	94

Useful Techniques

Procedure for examining pollen tubes -----	95
Rooting of zigzag clover cuttings -----	95
List of publications -----	96



PASTURE RESEARCH IN THE NORTHEASTERN UNITED STATES

This report, the twenty-fifth in the series, was prepared by and is intended primarily for use of personnel engaged in forage research in the twelve Northeastern States. It contains a summary of progress during 1961, reflects an appraisal of problems and provides information that should benefit all cooperating states. Included are reports from research scientists at the U. S. Regional Pasture Research Laboratory, from the northeast forage crops technical committees, from research workers at the state experiment stations and from personnel of the Forage and Range Research Branch at Beltsville, Maryland.

Collaborators assembled materials from their respective stations, chairmen of regional technical committees supplied reports of their activities, and scientists at the Pasture Laboratory and at Beltsville prepared reviews of their forage research related to this region.

The only personnel change at the Pasture Laboratory involved the appointment in July of Mrs. Dawn Neidigh as part-time assistant to the secretary, Mrs. Lois L. Smith.

After The Pennsylvania State University indicated that several areas used by the Pasture Laboratory for field studies would be required for other use, an area near the University Airport about five miles north of the Laboratory was assigned for our use. A new shed was erected there to house field equipment and to provide limited storage space.

An administrative conference of the Collaborators and ARS-CRD representatives from Beltsville was held at the Laboratory September 6-7. A review of responsibilities and recommended limitations of authority in activities dealing with cooperative forage research at state stations clarified Collaborator-Laboratory relationships. The report prepared in 1960 by a committee from the Collaborators was carefully reviewed. Parts of the "guide" to functions and responsibilities mimeographed in 1959 were discussed. Minor changes were made to be included in a revised edition. It was concluded that "Collaborators together with appropriate representatives from the participating ARS Branches and the Laboratory specialists shall make recommendations concerning the Laboratory research program." At the business meeting, the Collaborators elected R. B. Alderfer, chairman and W. H. Mitchell, secretary for the coming year and expressed the wish that a subject-matter conference dealing with Diseases and Insect Pests be held in 1962.

RESEARCH AT THE PASTURE LABORATORY

GENETICS, PATHOLOGY AND ENTOMOLOGY

Alfalfa

Creeping-rooted Alfalfa

Twenty-four hundred creeping-rooted plants from 30 crosses among selected clones and clones with leaf-disease resistance were established in a space-planted nursery and overseeded with timothy in the fall. These long-range objectives were advanced one year and the material will be used in future cycles of selection. A study on performance of a 3-clone synthetic of creeping-rooted alfalfa was initiated in cooperation with Dr. J. B. Washko of the Department of Agronomy at the Pennsylvania Experiment Station.

Selection for Disease Resistance

Ninety-six alfalfa clones selected in 1959 for resistance to Pseudopeziza medicaginis and Ascochyta imperfecta plus clones C318 and C319 were increased vegetatively and sent to Utah for polycross seed increase.

Another cycle of selection was initiated in 1961 to obtain further data on material descended from the 1959 clones and to have advanced clones in case a higher degree of disease resistance is needed. One hundred disease-resistant plants from the 1960 nursery were brought into the greenhouse in November 1960. In most instances two plants were selected from each cross or self. During the 1960-61 winter the clones were sib-crossed and selfed. Very few seeds were obtained from selfing.

In the spring of 1961, approximately 400 seedlings from 47 crosses were started in flats. The seedlings were inoculated with P. medicaginis. The crosses varied in susceptibility from 1 to 60%, averaging 16%. Buffalo and Vernal seedlings were rated approximately 90% susceptible (300 seedlings examined). Resistant seedlings from the crosses were transplanted to the field. Final disease notes will be taken in 1962.

Non-emasculated topcrosses were made between 50 clones selected for resistance to Pseudopeziza medicaginis in 1960 (progeny from 1959 Utah clones) and 5 susceptible plants. Two of these plants were Buffalo and three were Vernal. Reciprocals were kept separate. The crosses to Buffalo and their reciprocals ranged 0-48% resistant plants while crosses to Vernal and their reciprocals ranged 0-40% resistant. In most cases the percent of plants rated susceptible and resistant corresponded rather closely for the reciprocals of each cross. Results indicate that resistance is not dominant over susceptibility and that resistance is possibly controlled by additive genes

in the 1960 resistant clones. Differences in resistance of the plants of the different topcrosses were evident. Some variation among crosses can be traced to heterogeneity of soil in the field plot and to heavy rust infection of plants in certain areas in the field plot. Disease notes will be taken again in 1962.

Rapid Screening of Alfalfa for Resistance to Corynebacterium insidiosum

The petiole method of inoculation continues to be effective in screening seedlings. In 1961 various phases of the procedure were studied. First, C. insidiosum was readily isolated from yellow leaflets of inoculated petioles, thus showing that bacteria do enter and multiply in the leaflets--and not just translocate a toxic product.

In another experiment bacterial growth was collected from agar, the cells were washed, and then concentrated by centrifuging. The scum was heated (to kill bacterial cells) and also used for inoculum. Normal cultures were used for comparison. The concentrated cells caused the inoculated leaves to yellow more rapidly and more severely than normal colonies. The heated scum caused no yellowing.

Wilt Resistance in DuPuits

S₁ seedlings from two supposedly resistant DuPuits plants (1960 Annual Report, page 43) were inoculated twice by the petiole method and twice by the root-soak method. As of December 1961, S₁ plants from clone RDP #1 have been reduced from 165 to 10, and from RDP #3, reduced from 60 to 8. These healthy, vigorous plants were crossed (RDP1 x RDP3) and selfed in the greenhouse during the winter of 1961-62. Field plots of the above material along with DuPuits will be established in 1962. It is hoped that it can be determined if the progenies are DuPuits or not. Plots may be established in a wilt-infested soil.

Crown and Root Rot of Alfalfa

It is thought that if the common, weakly parasitic and secondary soil organisms could be inhibited, delicate, highly pathogenic organisms might be recovered from diseased crowns and roots of alfalfa and other legumes. The idea was partially proved in 1961. With an antibiotic medium meeting the above requirements, a Phycomycete (probably Phytophthora) was isolated from diseased alfalfa from University Park and two other locations in Pennsylvania. Preliminary inoculation experiments indicate that the isolates are pathogenic. More precise experiments are in progress.

Symptoms produced by the fungus are usually discolored (black) bands around the tap or secondary roots.

Combining Disease and Insect Resistance

Approximately 1400 plants from 39 apparent leafhopper-resistant clones in chaincrosses and crosses with leaf disease-resistant clones were established in May. Plants were rated in August for differences in growth and color owing to leafhoppers. Color differences were noted among several lines.

Survey for Weevil in Pennsylvania

The alfalfa weevil was found in Armstrong, Beaver, Clarion, Elk, McKean, Potter, and Tioga Counties, Pennsylvania, for the first time this year. It first appeared in Centre County in 1957. This season virtually all Centre County fields received weevil injury.

Coumestrol in Alfalfa Varieties at Different Locations

The Pasture Laboratory furnished samples of Buffalo, DuPuits, Lahontan, Ranger and Vernal to Albany, California for coumestrol determination. The coumestrol content at 1/10 bloom was highest at the first cut. Two varieties sampled at 5 growth stages gave highest coumestrol content 25 days after full bloom.

Clovers

Interspecific Hybridization and Cytogenetics

Compatibility reaction of first generation inbred progenies of self-compatible hexaploid Trifolium repens x T. nigrescens hybrids and of F_1 plants from crosses between self-incompatible and self-compatible hexaploids gives evidence to support the conclusion that the S-alleles of the 2 species were situated on chromosomes belonging to a common genome.

Extensive hybridization attempts involving diploid ($2n = 16$) T. hybridum, T. michelianum, T. nigrescens and tetraploid ($2n = 32$) T. repens resulted in pod formation in most combinations. Only T. repens x T. nigrescens resulted in hybrids. Excised embryos of the other cross combinations were cultured on a nutrient medium but the surviving seedlings were later identified as the result of selfing. Crosses at the tetraploid level of diploid species were also unsuccessful. The results demonstrated very strong barriers to species compatibility within section Euamoria of Trifolium. Italian accessions of T. nigrescens were more cross compatible with T. repens than Turkish accessions and the best results were obtained when they were used as pollen parents. The hybrids from the Italian pollen parents were more vigorous than those from the Turkish pollen parents. This may have been conditioned by the fact that the T. repens tester had germplasm in common with Italian Lodi white clover.

Selection for Persistence in Red Clover

Two nurseries were established in 1961 using the polycross seed harvested in 1960 from selected clones. In one nursery, plots were 2' x 5' and replicated 2 to 7 times based on the availability of seed. Also included was seed from plants selected to have IB and from plants selected for resistance to IB. Pennscott, Kenland, and Lakeland were seeded for comparisons.

Twenty-two of the selected clones produced from 50 to 100 gm of seed. Additional plots, 5' x 10', of this seed were established (4 reps.). The 3 commercial varieties were also included.

Effect of Fungicides (F) and Insecticides (I) on Persistence of Red Clover

Twenty-foot square plots of red clover, in latin-square design, were seeded in May 1960 and subjected to the following treatments: 1) Frequent applications of fungicides, 2) insecticides, 3) both pesticides, and 4) check (no pesticides). Beginning in April 1961, 10 plants from each plot (top 10' x 20' area) were dug and examined in alternate weeks by an entomologist and a pathologist for the following factors: root diameter, % of plants with IB, % of plants with root and crown rot and severity of rot, % of plants dead or with tap root rotted off, % of plants showing Sitona damage, % of plants infested with root borer.

Data of 8 months of sampling indicate that IB was not affected by the 4 treatments and the incidence in second-year plants increased little from April to November. Root diameters increased from 7 mm to 10 mm during this period. Plants from the check plots were smallest.

Because plants were attacked by Sclerotinia in the spring of 1961, all plots were sprayed with PCNB. By July twice as many of the plants (63-78%) in F and CK plots showed root and crown rot as those in I and IF plots. By the end of the season the % of plants with root and crown rot was 93-95 in F and CK plots and were rated moderate to severe, while in I and IF plots, 80-85% of the plants showed rot and were rated only slight to moderate. The severity of rot was reflected similarly in the % of plants dead or with tap root rotted off. Plants in F plots were only slightly less diseased than those in CK plots.

Sitona damage was reduced from 66 to 15% by the application of insecticides. Borer was almost completely eliminated. It appears that insecticide was the primary factor in reducing the severity of root and crown rot in red clover. Fungicides had only a slight effect. These conclusions are supported in % ground cover, vigor and yield of plants in the 4 treatments. Similar notes will be taken in 1962. This should aid in the determination as to whether red clover is biennial or perennial.

Factors Affecting Internal Breakdown (IB) in Red Clover

Several experiments were conducted in 1961 to try to change the incidence of IB in red clover. In one test the following substances had little effect on IB incidence: Gibberellic acid, mineral oil, iodoacetic acid, antibiotics, benzimidazole, serine, and indole-3-acetic acid.

In another experiment, various ratios of K, Ca, Mg and B fertilization had only a small effect on the incidence of IB. The application of manure and two inorganic sources of nitrogen also failed to influence the incidence of the physiological breakdown.

In two other experiments, IB was not affected by increasing the concentration of CO₂ around the crowns nor by the introduction of sucrose into the crown tissue.

Disease Resistance in Red Clover as Affected by Mg, K, Ca, and B Fertilization

In three inoculations red clover plants growing in soil high in Mg developed less Leptosphaerulina (Pseudoplea) leafspot than plants growing in low-Mg soil. Other treatments had no effect on disease severity.

Relationship between Feeding by Calomycterus setarius and Fusarium Root Rot in Red Clover

Results of an experiment conducted with Calomycterus setarius and Fusarium on red clover in the insectary and greenhouse from August 1959 to January 1960 suggested a relationship between root rot and feeding. The experiment was repeated from August 1960 to February 1961 for more positive evidence. An examination of the top growth, root system, and rot in these plants was again inconclusive although 245 C. setarius larvae were recovered from the insect and insect-Fusarium infested pots. Two plants per crock were used in this experiment, and results showed that plant competition was considerably greater than any injury owing to the feeding larvae. A comparison of root systems showed that check plants had more fine rootlets than infested plants.

This experiment is being repeated in the greenhouse for a third time, this time, using one clover plant per crock to eliminate plant competition.

Clover Root Curculio Flight Period

By use of a sticky-board trap it was determined that new adult clover root curculios have a late summer and early fall flight period.

Species of Leptosphaerulina (Pseudoplea) on Forage Legumes

Cooperative research with E. S. Luttrell, Ga. Expt. Sta. on the taxonomy, physiology, and pathology of Leptosphaerulina has been completed and published.

Orchardgrass

Breeding Improved Dactylis glomerata

Notes on plant color (Score 1 = light green, 2 = medium and 3 = dark green) and on straw stiffness (1 = soft, 2 = intermediate, 3 = stiff straw) were taken in June in the 1960 polycross nursery. Maturity estimates of the 86 entries were based on these scores: 1 = first head in boot; 2 = intermediate; 3 = head visible, boot spreading; 4 = intermediate; 5 = head 1/2 out of boot; 6 = intermediate; 7 = head beginning to spread; 8 = intermediate; 9 = onset of anthesis; 10 = full anthesis. The nursery was rated for maturity on June 1, June 7 and June 12. Seven was the highest score on June 1 and 42 clones averaged higher than 6. Because these clones, including the MIV-5 parent of Pennlate, were earlier than desired in this test, their tops were removed on June 8. Seed yield of the remaining clones was not correlated with maturity ($r = -0.03$) but was correlated with rust scores given in 1960 ($r = -0.49^{**}$). The negative correlation resulted because the high rust score was for most susceptible plants (1960 Annual Report, page 13). Twelve of 24 clones that yielded 1 lb. or more seed were late maturing with a score of 8.6 or higher and 12 were very late with a score of 8.5 or less. The latter group included the XLI-8 parent of Pennlate. The other 2 parents MIV-17 and XLI-17 yielded 0.7 and 0.6 lbs. seed, respectively. Nurseries for polycross progeny testing of selected clones will be established in 1962 in cooperation with the Department of Agronomy at The Pennsylvania State University. The parent clones will also be selfed in the field in 1962. Several promising medium-late clones with rust resistance will be established in a restricted polycross nursery.

Orchardgrass with Male-sterility

S₁ progenies of possible genetically heterozygous male-fertile clones were examined in the field for presence or absence of pollen. Eight clones considered to be heterozygous male-fertile were used as male parents in crosses to normal clones. Progenies will be examined for male-fertility and will be intercrossed or selfed. If male-sterile plants are obtained, cytoplasmic male sterility can be ruled out as affecting fertility in this material.

Adult Spittlebug Injury on Orchardgrass

Adult spittlebugs retarded growth when caged on orchardgrass. One hundred adults caged 14 days on potted orchardgrass shortened growth by an average of 1.8 inches and reduced green weight by an average of 1.4 g under check plants.

Selection for Fertility in Derivatives of Intergeneric Hybrids

Cytological examinations were made of progenies from 2 tetraploid ($2n = 28$) clones derived from triploid Lolium-Festuca. The negative correlation between univalents at MI and lagging univalents at AI was non-significant, $r = -0.32$. No correlation existed between number of micronuclei per quartet and percentage of stainable pollen, $r = 0.07$. Twenty-six vigorous tetraploid clones with low pollen fertility were planted in a topcross nursery with 5 medium-fertile clones. Autotetraploid meadow fescue was also interplanted in this nursery to obtain new source material of tetraploid hybrids.

As mentioned in 1960 Annual Report, page 14, intergeneric hybrids were backcrossed to tall fescue. Approximately 95% survived the winter. Six hundred twenty-two of 707 plants were male-sterile and the 85 remaining plants varied in percentage of stainable pollen. Eighty-two male-sterile plants averaged 8.1 g seeds and 48 plants with stainable pollen ranging from 1-97% averaged 8.2 g per plant which indicated that the pollen sterility estimates were unreliable measures of female fertility. The correlation between mean seed yield of 2 samples of 10 panicles each and total seed yield per plant was highly significant, $r = 0.79$. The increased seed fertility in many Lolium-Festuca derivatives is very encouraging. Fifteen clones and 18 clones were established in separate polycross nurseries, respectively. Open-pollination progenies of representative clones which were found to be $2n = 42$ suggested that polycross progenies may also stabilize at the hexaploid level.

Cytogenetics of Kentucky Lolium-Festuca

Cytogenetic analyses have been made of intergeneric hybrids and backcrosses of these to annual and perennial ryegrasses that were produced in R. C. Buckner's program at Kentucky. A high frequency of $2n = 56$ derivatives was determined among progenies of octoploids and suggested the possibility of obtaining stable hybrids at this chromosome level. The variety of ploidy levels observed in general indicates the difficulty of achieving stable synthetics in early stages of intergeneric hybridization work.

Bromegrass

Selection for Disease Resistance

The 19 clones with resistance to Helminthosporium bromi and Stagonospora bromi (1960 Annual Report, page 16) were established in a restricted poly-cross nursery on May 23. Twenty replicates of one plant per replicate are expected to yield sufficient seed in 1962 for a progeny evaluation test.

Stagonospora bromi

In artificial inoculations of 2 varieties of Bromus inermis, infection was most severe on plants kept at 24, slightly less at 21, and least at 27 C. Young plants of orchardgrass, timothy, meadow fescue, tall fescue, redtop, perennial ryegrass, reed canarygrass, and Pennoll wheat were nonsusceptible to S. bromi in greenhouse inoculations.

In laboratory studies, no consistent effect of previous incubation temperature upon spore discharge of S. bromi was detected. Contrary to a recent report in the literature, no Phyllosticta stage was observed to be associated with S. bromi. However, a Mycosphaerella sexual stage developed in cultures of an Ascochyta sp. isolated from brome grass leaves. The sexual fruiting bodies arise from the asexual pycnidium. Neither conidia nor ascospores were pathogenic to Bromus inermis in artificial inoculations.

Survey of Insects on Brome grass and Timothy

A survey showed the most abundant economic insects to be grasshoppers, Japanese beetles, flea beetles, three different plantbugs, the meadow spittlebug and five different leafhoppers.

BIOCHEMISTRY, PHYSIOLOGY AND SOILS

Carbohydrate Studies on Grasses

(In cooperation with D. G. Routley of the New Hampshire Station)

At present, carbohydrate studies are confined to (1) the composition and properties of some prepared celluloses, (2) the hydrolysis of hemicelluloses, and (3) the relation between ease of hydrolysis of hemicelluloses and the degree of lignification and digestion coefficients of different forages.

Monoethanolamine cellulose was described previously (1959 Annual Report, page 20). Further studies were made with this form of cellulose isolated from grasses, legumes, and feces of animals fed these forages and the preparations were compared with Crampton and Maynard celluloses from the same sources. The monoethanolamine celluloses were lower in quantity than the C&M celluloses from the same source. All contained considerable quantities of ash and lignin. There were more of these contaminants in the C&M celluloses than in the monoethanolamine celluloses, more in the celluloses of the legumes than in those of the grasses and more in those of the feces than in those of the forages. The glucose contents of the celluloses, though these were not obtained with high accuracy, were lower in the C&M celluloses than in the monoethanolamine celluloses, particularly in those of legumes and legume feces. These differences in the celluloses tend to disappear when they are calculated on an ash-free and lignin-free anhydro-glucose basis. The results suggest that the C&M cellulose, which has been accepted as being close to pure cellulose, is not as pure a substance as that isolated as monoethanolamine cellulose. An explanation of these results is offered in that there is some material in C&M cellulose which is not converted to a reducing sugar on hydrolysis or is converted to one of less reducing power than glucose, and that this substance occurs to a less extent in the feces than in the forage so that it appears to be absorbed in its passage through the animal. This is borne out by some calculated digestion coefficients. In 7 grasses the digestion coefficients of C&M cellulose averaged 73.5 as compared with 71.5 for the monoethanolamine celluloses. In 3 legumes the figures were 70.2 and 66.7. These results indicate that monoethanolamine cellulose may be a more desirable substance than C&M cellulose for some forage studies.

Losses reported in the preparation of holocellulose (1960 Annual Report, page 19) have led to the discontinuance of the use of holocellulose as an intermediate material in the study of hemicellulose. Forage samples are now being hydrolyzed with only one preliminary treatment, extraction with benzene-alcohol. Samples of grass were treated with dilute sulfuric acid at 100° C and the hydrolytic products were examined quantitatively. The acid had two effects, partial hydrolysis of the hemicellulose to sugars and solubilization of portions of the hemicellulose. These portions were not completely hydrolyzed to free sugars but could be hydrolyzed after additional treatment with stronger acid. Therefore, two kinds of data were obtained, the reducing power of the hydrolyzate directly and the reducing power after further hydrolysis. The difference between the two gives a measure of the

amount of the hemicellulose fragments released but not completely hydrolyzed. The measure of the reducing power is therefore not a complete measure of the breakdown of the hemicellulose but approaches it under conditions of hydrolysis with stronger acid, 1.0 N, of sufficient duration, 6-8 hours.

It was noted that hydrolysis of hemicellulose was more rapid in earlier cut forages, with lower lignification and higher digestion coefficients than it was in forages of higher lignification and of lower digestion coefficients. This phenomenon is being studied from the standpoint of the evaluation of forages for their feeding value.

Measurement of the Feeding Value of Forages by Chemical Analysis

These studies have been carried on for some years in cooperation with the Technical Committee NE-24, "The Nutritional Evaluation of Forages." About 300 samples of forages of known digestion coefficients have been received and analyses have been made and are being continued. The objective is to determine how close digestion coefficients can be predicted from the amount of one or more constituents found by analysis. Up to the present many criteria have been studied, as lignin, fiber, protein, etc., and all give some prediction values but none is completely satisfactory. The chief difficulty is that the same criterion will not apply equally to both grasses and legumes and the error of prediction is high, particularly in grass-legume mixtures. New methods are being sought.

A new procedure is being studied. The ratio of the xylose released by 0.1 N sulfuric acid in 1 hour to that released by complete hydrolysis, viz., by 1.0 N acid in 8 hours, is related to the digestion coefficient of the dry matter of the forage. In 11 samples this ratio ranged from 0.11 to 0.30. The correlation coefficient between this ratio and the digestion coefficient of dry matter was +0.96.

Preservation of Fresh Forage

(In cooperation with T. V. Hershberger of the Pennsylvania Station
and D. G. Routley of the New Hampshire Station)

As previously reported (1960 Annual Report, page 21) fresh forage may be preserved with a number of chemicals. Two that received special attention were propylene oxide and ethylene oxide. Forages preserved in 1-pint jars or 1-quart or 1-gallon cans with either of these substances had little or no odor, the pH values were equal to or slightly higher than those without preservative and losses in dry matter were insignificant. Volatile acids were not present as a rule, the greatest quantity of acetic acid found was 0.30% of the dry matter and of butyric acid 0.04%. The quantity of propylene oxide needed was about 1% of the fresh weight of the forage. Treated forage was eaten by sheep with no noticeable distaste or harmful effect.

Climate at State College

Monthly air temperatures were near normal during February, March, July, November and December but were below normal in January (-9°), in April (-5°), in May (-5°) and June (-2°). During September temperatures were 6 degrees above normal and in October $+2$ degrees.

Precipitation during the year was near normal except for periods below normal during January ($-0.71''$), May ($-2.20''$), September ($-0.73''$), October ($-1.09''$), and December ($-1.24''$) and above normal during April ($+0.71''$), July ($+1.08''$), and August ($+1.70''$).

Soil moisture 4 inches beneath a clipped bluegrass sod was at field capacity in April, decreased to 30% available water in June, then increased to 41% and 46% respectively in July and August. In September, moisture decreased to 39% in the 4-inch layer but was 53% at the 8-inch level. One hundred eighty-seven days occurred between killing temperatures of 28°F ; the last such temperature in spring was on April 19 while first in the fall occurred October 23.

During late winter 1961, soil temperatures increased to 32° at depths of 16, 12, 8, 4, and 2 inches beneath a grass sod covered by heavy snow on February 4, 6, 10, 13, and 13 respectively. Dates in the fall when temperatures first decreased to 31° at the 2- and 4-inch depths were December 15 and 30, and at 8-, 12-, and 16-inch depths the soil remained above freezing.

Snow cover was 10 inches in January 1961 and increased to 24 inches on February 4. This was followed by gradual melting with only traces remaining after February 24. Scattered snowfalls of 1 to 5 inches, melting within a day or two, occurred March 9, 14, 22, April 1, 10 and 15. A total of 94 inches of snow fell during the winter of 1960-61.

Regional Climate Studies

(Cooperative with 10 States in NE-29)

Daily observations of precipitation, soil moisture, air and soil temperatures, dew, and other items affecting plant growth were sent monthly from 10 stations to the Pasture Laboratory for summarizing on a bi-weekly basis.

Precipitation in the region varied with location and season. In January and December 1961, precipitation was below normal at all locations and during April it was above normal. Precipitation in May and July was near normal in most states while in both March and October precipitation was near normal or lower.

Air temperatures were appreciably below normal (between -5 and -10 degrees) in all states during January 1961 and also during April and May (between -3 and -6 degrees). During September, temperatures were between 4 and 6 degrees above normal and during February and October between 1 and 3 F above normal.

Mean soil temperatures were not so low during the winter as might be expected from the low air temperatures, because heavy snow cover reduced heat losses from the soil. Soil temperatures at 4-inch depths during the summer months averaged 74° in Pennsylvania, New Jersey, and Connecticut, and 69 F in Maine.

Soil moistures were near field capacity during April and May at most locations and decreased to near 50% of available water during the summer months.

The last dates in the spring on which freezing temperatures occurred varied from April 3 in West Virginia to May 31 in New Hampshire and Vermont. Dates of first freezing temperatures in the fall ranged from October 15 in New England to November 8 in West Virginia. The number of days between freezing conditions ranged from 139 days in Vermont to 219 days in West Virginia.

Legume and Grass Seedling Establishment

Spring observations of 1960 seedlings indicated that no heaving had occurred. Plants from the earliest seeding were largest for alfalfa, orchardgrass, brome grass, and reed canarygrass. Under all times of seeding plants of birdsfoot trefoil were similar. The seedlings of Ladino clover were smaller when seeded earliest and larger when seeded at the other three later dates.

Seedling establishment studies on field plots were repeated using alfalfa, Ladino clover, birdsfoot trefoil, orchardgrass, reed canarygrass, and brome grass. These were seeded 1/2 inch deep in rows and covered with fine soil. Only natural precipitation provided moisture. The first seeding was on April 21 and subsequent seedings were on May 15, June 6 and June 30. Best stands of all species occurred after the April 21 seeding that was followed by favorable precipitation. Generally, mid-May seedings were poorer except

for alfalfa and brome grass which emerged following several small showers. The June seedlings were almost as good as those in April, again owing to favorable rain periods.

The importance of precipitation is evident for both grasses and legumes. Seeding in April was most favorable because even when germination was not immediate, later rains and warmer temperatures permitted more rapid germination and good establishment.

Biological Method of Measuring "Reserves" in Field Plants at Varying Stages of Maturity and of Seedlings at Various Ages

(Co-operative with 9 Northeastern States)

This work followed that reported previously (1960 Annual Report, pages 25-27). In 1961, primary emphasis was on: 1) established plants of orchardgrass, brome grass, and timothy grown both in the field and in the greenhouse and 2) seedlings of orchardgrass, reed canarygrass and oats at two-week-age intervals within two months following emergence.

A biological technique was used to measure the reserves in grasses during their recovery after cutting at different stages prior to head formation. Orchardgrass, brome grass and timothy grown in the greenhouse during the winter were stimulated to flower. Plants were cut at the vegetative, early boot, head-expanded and full-bloom stages and then placed in the dark and allowed to recover several weeks.

The weights of dry matter produced in the dark, expressed as mg/tiller, indicated that reserves were high prior to head initiation, decreased during early head formation, and then increased when plants were in full bloom. Trials to measure effects of recutting after partial recovery in the light indicated that when plants were cut at the early boot stage, a 2-weeks' longer recovery growth period was required for replacement of the energy utilized during head initiation than was required when plants were cut at the vegetative stage.

During seedling establishment, the energy in the seed and its change in the seedling for 12 weeks was biologically measured by growth in darkness. In oats the dark-recovery weights increased sharply after 6 weeks' growth. In orchardgrass and reed canarygrass, a sharp increase was evident after 8 weeks. Orchardgrass seedlings under a long photoperiod produced the same dark-growth in 10 weeks that required 12 weeks under a short photoperiod. Generally, the biological measurements of reserves (accumulated energy) provided an indication of prior conditions and an understanding of growth in relation to the energy fixed by photosynthesis and its subsequent use. It is planned to study further the interactions of environmental factors such as light and temperature with the height and frequency of defoliation in relation to expected rates and amounts of growth produced. Relationships of the biological and biochemical measures of accumulated energy will also be studied.

Temperature and Plant Growth

Work was continued cooperatively with D. E. McCloud and C. W. Alexander, Agricultural Research Service, Crops Research Division, Beltsville, Md., on the experiment initiated (1957 Annual Report, pages 20-21 and 1958 Annual Report, pages 25-26) to measure plant growth responses to variations under similar mean temperatures. During 1961, 90-degree mean temperatures were studied. Germination and dry matter production of seedlings of 4 legumes and 4 grasses were obtained under four 90-degree mean temperatures.

One group received 90-degree constant air and soil temperatures; another a 90-degree mean that resulted from alternating both air and soil temperatures 80 to 100°; a third was constant 90° air and alternating 80-100° soil; and the fourth received constant soil with alternating air temperatures.

Light from fluorescent lamps provided a light intensity of 650 footcandles with radiation of 1.4 gm calories/cm²/min under a 15-hour day. Alternating air and soil temperatures were similar to those normal for a day in July in State College, Pa. All species grew least under constant temperatures and greatest when air was constant 90 F and the soil alternated 80 to 100 F. Alternating both air and soil, and alternating air with constant soil temperature provided intermediate growth. The germination of Kentucky bluegrass was almost zero under a constant temperature of 90° while under alternating 80-100° germination was markedly increased. Temperature alternations did not greatly change the percent germination of brome grass, alfalfa, and red clover. This test indicated that growth was markedly decreased under constant air and soil temperatures and that some species were affected more than others. This study indicates that the ranges of daily temperature changes need consideration when mean temperatures are compared.

Physiological Studies on Root-spreading Alfalfa

The investigations previously initiated (1960 Annual Report, pages 27-28) were continued with primary attention to determining effects of the environmental factors of photoperiod, temperature, and defoliation on the formation and development of adventitious stems on the roots of creeping-rooted alfalfa. Several clones varying in degree of expression of the creeping habit and in general vigor of growth responses were selected for use in these studies. Five clones were used in a greenhouse trial to study effects of four combinations of photoperiod and temperature and two defoliation frequencies on the formation of adventitious stems on roots of alfalfa. Adventitious stem formation was enhanced by short-day conditions and decreased by cool temperatures and frequent defoliation. Cutting creeping-rooted alfalfa at four stages of maturity (early bud, full bud, 1/10 bloom and full bloom) throughout the growing season indicated decreased development of adventitious stems when cuttings were made at less mature stages of growth.

Growth of Ladino Clover Seedlings in Association with Orchardgrass

The investigations on specific factors affecting Ladino clover grown in association with orchardgrass (1960 Annual Report, pages 28-29) received further attention. Measurements were obtained of dry matter produced by Ladino clover grown alone and in association with orchardgrass in gravel cultures at two nutrient concentrations, X and 4X. When Ladino clover and orchardgrass were grown in association each species was in a separate pot supplied with nutrient solution from a common reservoir. In one treatment intact grass roots were leached with distilled water for a period of four days to investigate the possibility of release of a growth inhibiting substance by orchardgrass. Growth of Ladino clover when provided with either the original or leachate solution was similar or slightly less than that grown on soil fertilized with regular additions of complete nutrient solution. Growth of Ladino clover in a nutrient solution changed weekly, that concurrently supplied the orchardgrass, was 80% of that on fertile soil. When macro-elements in the nutrient solution were maintained, but the solution was not changed during the course of the experiment (6 weeks), growth of the Ladino clover was about 1/3 of that produced on soil. When orchardgrass was grown in an unchanged solution concurrently bathing Ladino clover, the growth of clover was reduced at both nutrient concentrations.

Nutrient solution replacement techniques, solution analyses and plant tissue analyses indicated that adequate amounts of N, P, K, Ca, and Mg were available for plant growth at all times. Plant tissue analyses suggest that high boron and/or low iron may have limited growth. Further studies are necessary to demonstrate conclusively the presence or absence of a substance released by orchardgrass that inhibits growth of Ladino clover seedlings. However, the evidence obtained in this study indicates that any role played by a hypothetical growth inhibitor released by orchardgrass would be minor compared to the role played by nutrient competition, etc. This study demonstrates the complicated nature of the competition for nutrients by such diverse species as orchardgrass and Ladino clover.

Establishment of Ladino Clover in Orchardgrass Sods

Technique for evaluating competition for above- and below-ground factors in grass-legume associations---Three populations of 8, 13, and 18 established orchardgrass plants per container 15.0" square, and 6.75" deep were combined with four competitive situations: no competition for above- or below-ground space, competition for below-ground space only, competition for above-ground space only, and full competition for above- and below-ground space, were seeded to Pilgrim Ladino clover. The effect of the orchardgrass populations and competitive situations on the growth of Ladino clover seedlings was then evaluated during two six-week-growth periods. One trial was conducted in the greenhouse, and the second trial in the garage growth chambers. "Masonite"

dividers were used to segregate root systems in a mixed block of well-established orchardgrass plants and Ladino clover seedlings, galvanized wire screens in the first trial, and clear plastic-coated screens in the second trial to segregate plant tops. Clipping treatments consisting of weekly clipping to 3 inches, or to 10 inches were superimposed in the second trial in order to simulate the desired competitive situations.

In the first trial, the galvanized wire screens gave a negative effect on the growth of Ladino clover and orchardgrass. Further, the growth of the orchardgrass was related to the amount of soil available to it, and thus competition for above-ground space was less in the no-below-ground competition situations. Therefore, competitive effects were confounded in the first trial.

The clipping treatments, the use of plastic-coated wire screens, and constant overhead lighting in the second trial resulted in the complete attainment of three of the four desired competitive situations. Elimination of competition for above-ground space without corresponding reduction in below-ground competition was not obtained.

The second trial indicated that populations of 13 and 18 orchardgrass plants per container were too high to evaluate competition effects. The increase in Ladino clover seedling growth brought about by the elimination of both below-ground and above-ground competition was about four-fold. Below-ground competition appeared to have the largest influence on the growth of the Ladino clover, although severe clipping treatments were highly beneficial. The clipping treatment did not result in vigorous Ladino clover seedlings when root systems were not segregated.

The inhibition of Ladino clover seedlings by orchardgrass plants may be explainable on the basis of interacting effects of eliminating competition for both above- and below-ground factors. The elimination of one or the other did not result in vigorous Ladino clover seedling growth. Competition for nutrients, light, moisture, etc. and their interacting effects explained the depressed growth of Ladino clover in orchardgrass sods. However, the depression in Ladino clover growth with severely clipped orchardgrass plants is still difficult to explain. No evidence for release of an allelopathic substance by orchardgrass roots which might be inhibitory to Ladino clover seedlings was obtained.

Specificity of competition between seedlings of various plant species and established orchardgrass plants---An exploratory experiment involving planting of 4 species: Pennoll wheat, Piper Sudangrass, Viking birdsfoot trefoil, and Vernal alfalfa in established orchardgrass, and in monoculture indicated that wheat competed better with orchardgrass than did the Sudangrass, birdsfoot trefoil, and alfalfa. This was in spite of an apparent nitrogen deficiency in wheat.

The inhibition of growth of seedlings was general, but the magnitude of the inhibition varied with species. Most of the inhibition of seedling growth was probably due to competition for known above- and below-ground factors.

Effect of decaying orchardgrass roots on the growth of Ladino clover seedlings---Ladino clover seedlings were grown in greenhouse soil in which 0, 0.5, 1.5, and 3.0% dry orchardgrass roots were incorporated. The soil plus orchardgrass roots was incubated in a moist condition for 3 weeks at either 2 or 27 C prior to planting of Ladino clover. Dry weight and survival of Ladino clover was taken as the estimate of the effects of decomposing orchardgrass roots on Ladino clover seedling growth. Two consecutive trials using the same pots were conducted.

Large quantities of dried orchardgrass roots mixed with soil and allowed to decay had little or no detrimental influence on the growth of Ladino clover, although at the very highest concentration of orchardgrass roots, 3% incubated at 27 C, survival of Ladino clover seedlings was reduced by roughly half. The significance of this observation is not known.

Further studies are underway evaluating soil moisture level, and plant nutrients as factors in establishing Ladino clover seedlings in a vigorous orchardgrass sod.

Phosphorus Fertilization of Forage Grasses and Legumes

Effect of alternating soil and air temperature on the response of Piper Sudangrass and phosphorus fertilizer placement and rate---Two trials with Piper Sudangrass were conducted in the basement growth chambers under four different temperature regimes, and three phosphorus levels placed either in a band one inch below the seed or mixed with 2-1/2 inches of surface soil. The temperature regimes were as follows: both soil and air temperatures alternating between a minimum of 80 F and a maximum of 100 F; air temperature held at a constant 90 F, and soil temperatures alternating between 80 and 100 F; both air and soil temperature held at a constant 90 F; and soil temperature held at a constant 90 F with air temperatures alternating between 80-100 F. The phosphorus levels were as follows: 0, 17.5, 35.0, and 70.0 mg P_2O_5 in the first trial, and 0, 17.5, and 35.0 mg P_2O_5 per 1500 g of Morrison loam in the second trial.

The best temperature regime for the growth of Piper Sudangrass was the constant 90 F air temperature with alternating soil temperatures of 80-100 F. The next best temperature regime for Sudangrass growth was the constant 90 F soil and air treatment. The poorest growth of Sudangrass was obtained when soil and air temperatures alternated between 80 and 100 F.

Responses to phosphorus were comparable under all temperature regimes except at the alternating soil and air temperatures when it appeared that some factor(s) other than phosphorus supply was limiting plant growth.

Band placement of phosphorus one inch below the Sudangrass seed was consistently better than mixed treatments under all temperature regimes.

The phosphorus content (%) of the plant tissue varied very little, but was higher under the phosphorus fertilized treatments. Banding the phosphorus one inch below the seed apparently had very little influence on the phosphorus content (%) of the Sudangrass seedlings. Phosphorus content figures are based on a very limited number of analyses and should be considered tentative.

High maximum temperatures coupled with low light intensity may be more damaging to the growth of Sudangrass than previously thought.

A study on nutrient culture techniques preparatory to phosphorus withdrawal studies--A preliminary trial in solution culture was conducted to evaluate the technique proposed for nutrient withdrawal studies. The experimental variables used were two apparatuses: differing in size of nutrient reservoir, and ability to randomize replicates; and two sources of iron: FeSO_4 with nutrient solution buffered with glauconite to maintain a pH of about 4.9, and iron chelate. Each treatment was replicated three times. The results indicate that the iron chelate solution provided the better growth. However, this difference was probably the result of growth reduction caused by the release of a toxic substance, possibly aluminum, from glauconite at the acid pH's used with the FeSO_4 treatment. There was a small difference in favor of the 4-liter reservoir and non-randomized replicates. This difference was not considered significant, except for the importance of randomization.

Problems encountered in the manipulation of the apparatus and nutrient solutions were: 1) achievement of uniform flow rate across all experimental units, 2) failure to recognize the importance and procedure for increasing flow rate to compensate for rate of growth of plants, 3) formation of colloidal precipitates in the flow lines from nutrient reservoirs to plant containers in both nutrient solutions, and 4) the release of toxic substances from the material used to buffer the nutrient medium in the FeSO_4 treatment.

It seems wise to conduct the main experiments using nutrient solutions with lower phosphorus content, and iron supplied separately. The frequent determination of nutrient solution effluent pH should be a useful tool in adjustment of flow rate to the rate of plant growth.

Studies are underway evaluating the absolute and relative responses of selected grasses and legumes to phosphorus fertilization when other nutrients are non-limiting.

Soil toxicity caused by partial steam sterilization--Highly significant yield reductions in red clover top growth were caused by a soil toxicity encountered at the Pasture Laboratory. This toxicity was determined to be owing to an excess of available manganese released upon steaming the greenhouse soil. The results indicate that organic materials and soil manganese interact when steamed together to release more plant-available manganese.

Red clover and alfalfa seedlings were most sensitive to excess manganese. Ladino clover was only slightly sensitive to the levels present in the soil used in the experiment. Barley, birdsfoot trefoil, cucumbers, tomatoes, orchardgrass and Sudangrass were not affected by the concentrations of soil manganese in the steamed greenhouse soils. Buckwheat and tomatoes were not affected initially but both species developed slight toxicity symptoms at later stages of growth.

Lime was the most beneficial soil amendment in correcting the manganese toxicity. Recommendations for correcting this toxicity consist of liming to pH 6.5, and reducing the duration of steaming to a maximum of two hours at 2 lbs. steam pressure. In the future, it may be wise to add the peat after steaming.

Plant tissue analysis for manganese revealed that whole Pennscott red clover plants grown on steamed greenhouse soil contained an average of 690 ppm Mn, whereas red clover grown on the same soil unsteamed contained only 96 ppm Mn. Red clover leaves contained as high as 4080 ppm Mn on steamed greenhouse soil compared to 80 ppm Mn for leaves grown on unsteamed greenhouse soil.

Exploratory studies in seedling establishment of birdsfoot trefoil---A small trial evaluating the influence of various size fractions of air-dry soil particles on the germination and emergence of birdsfoot trefoil was conducted in the greenhouse.

Soil particle aggregates greater than .42 mm in size used as a mulch at the surface of the soil were beneficial in promoting the emergence of birdsfoot trefoil. The use of very fine soil-aggregate mulches (particles less than .42 mm in diameter) was detrimental to birdsfoot trefoil seedling emergence compared to that of the control, or coarse soil particle mulches. The most effective mulch in this study was No. 4 washed quartz sand.

The influence of soil particle size in the seedbed and soil-particle mulches on emergence of small seeded legumes should be studied in more detail.

An evaluation of distribution of fertilizer treatments mixed in soil by two methods---Excellent distribution of liming or fertilizer materials was obtained by quartering the entire soil sample, applying one-fourth of the liming material to each quarter, mixing each quarter first separately, and then jointly. Mixing the entire soil sample in a conventional cement mixer for five minutes was satisfactory for a 50-lb. and 100-lb. batch of soil. Liming the soil reduced the relative variation in pH. The reduction in variation was not sufficient to consider the limed treatments as belonging to another population. The use of a cement mixer for adding fertilizer materials to soils to be used in greenhouse studies is as satisfactory as careful handmixing.

RESEARCH AT BELTSVILLE, MARYLAND

Title: LEAF AREA VERSUS ROOT RESERVES IN REGROWTH

Leader: D. E. McCloud

At Beltsville, Maryland, in a management study, orchardgrass with high food reserves, produced regrowth in the first 3 weeks which was largely independent of leafage; and conversely was dependent upon leaf amount when food reserves were low. A 50-cm length of leaf blade provided adequate photosynthetic area to negate the effect of low food reserves. With high food reserve bromegrass, independence from leafage influence occurred only during the first week of regrowth, whereas with low reserves regrowth was highly dependent upon leaf amount. Only 25 cm of leaf length was adequate to negate the influence of low food reserves.

Title: GRAZING PRESSURE INFLUENCES BOTANICAL COMPOSITION OF PASTURES

Leader: D. E. McCloud

In cooperation with the Dairy Cattle Research Branch, a grazing pressure study has been conducted during 1960 and 1961. The pasture was an orchardgrass-Ladino clover mixture. Milk-producing dairy cows were used and the management system was 4-paddock rotational grazing. Three grazing pressure treatments were achieved by using pasture paddocks $1/2$, $3/4$, and 1 acre in size. During the first grazing season, botanical composition averaged 23% Ladino clover and 63% orchardgrass. The legume content declined to about 10% for the second season in all pastures, regardless of the grazing pressure treatment. During the first season the forage available when grazing began averaged 1300 lbs. per acre at each rotation. In the second season forage yields declined on the higher-grazing pressure treatments. The average before-grazing-forage yields were 1046, 943, and 846 lbs. per acre for the light, medium, and heavy grazing pressures. Intensive forage utilization resulted in a reduction both in intake and digestibility, based on chromagen-chromic oxide determinations. However, individual animal production was not seriously affected. Thus, it appears that high-grazing pressures may result in declining forage production and adverse shifts in botanical composition before milk production per acre is seriously affected.

Title: NITRATE ACCUMULATION AFFECTED BY ENVIRONMENTAL FACTORS

Leader: D. E. McCloud

At Ithaca, New York an experiment was conducted to study the accumulation of nitrate in oats under 3 daylengths, 2 levels of nitrogen fertilization, and with 3 soils containing varying amounts of sand. The amount of nitrate decreased by about 30% when the photoperiod was increased from 11 to 12 hours. But there was no appreciable decrease when the photoperiod was increased from 12 to 13 hours. The percent of nitrate in the oat forage decreased as the amount of sand in the soil mixture was increased. An attempt is now being made to determine the ability of a plant to reduce nitrate. Reductase activity of the plant material is being studied to determine its role in nitrate reduction.

Title: TREFOIL IMPROVEMENT

Leader: P. R. Henson

Recurrent phenotypic selection is being employed as a breeding method to develop lines of birdsfoot trefoil carrying greater seedling vigor and resistance to crown and root-rotting organisms. Two-year cycles are needed to secure satisfactory root rot ratings. Four groups of plants are included in this study. Significant improvement in progenies with respect to resistance to root rot and seedling vigor is apparent in the first cycle of selection. The study is being continued.

Title: CROWNVETCH IMPROVEMENT

Leader: P. R. Henson

The leaves of crownvetch contain significant amounts of phenolic substances which may be affecting the palatability of this legume as a grazing plant for cattle. Digestibility studies in cooperation with the Nutrition Section of the Animal Husbandry Division with sheep show crownvetch hay to be slightly under alfalfa hay in digestibility. Plants having a low concentration of phenolic substances have been found. Studies are planned to determine the importance of phenolic substances in the leaves on nutritive value and palatability of the species. The lines of crownvetch having low concentrations of phenolic compounds will be compared to common crownvetch in grazing studies.

REPORTS OF R. AND M. COOPERATIVE RESEARCH

Title: PROJECT NE-13 - THE MECHANIZATION OF FORAGE CROP HARVESTING, PROCESSING, STORING AND FEEDING--JANUARY 1, 1961 TO JUNE 30, 1961 and NE-13 REVISED - STUDIES OF THE PHYSICAL PROPERTIES, BEHAVIOR, AND FORMS OF FORAGE AS RELATED TO ENGINEERING APPLICATION--JULY 1 TO DECEMBER 31, 1961

Leader: E. C. Schneider, Chairman, Regional Technical Committee

Cooperators: The 12 Northeastern Agricultural Experiment Stations, and A.E.R.D.-ARS, and C.S.E.S.S. (U.S.D.A.)

PROGRESS OF WORK AND PRINCIPAL ACCOMPLISHMENTS:

Harvesting---The data collected on tractor-tire performance and legume recovery were analyzed and a publication drafted.

Tungsten carbide coated mower sections were tested, and over-all performance appeared good.

Preliminary tests were made with helical screws as forage cutting devices.

Data were analyzed in preparation for a publication on hay harvesting loss studies.

Processing---In haylage storage, summaries of the data were prepared. Studies of drying characteristics of chopped alfalfa hay clearly indicated the influence of varied bulk densities on the drying rate. A technique was developed for determining bulk density of silage under pressure. A wagon hay dryer was used to prepare hay for a study of the effect of drying temperature on nutritive value. Air flow equations were developed for baled hay. Partial recirculation of heated air in wagon drying systems for hay has proved more efficient than non-recirculation. Post-formation reaction forces of hay wafers were studied with an indication that wafers with the greatest reaction force were more stable. Studies were begun on the determination of exposed drying rates of forage crops.

Storing---Up to 65% of the labor can be eliminated by using mechanical systems in hay storage. A study of the performance of forage blowers with emphasis on material flow in a vertical pipe was continued. Studies of a high velocity air transportation system for high moisture hay show that as the flow rate increases, the air velocity decreases. Work continued on a belt-tube forage elevator. Large six-mil-plastic tubes for silage storage were tested and found unsatisfactory because of punctures.

Feeding---An electric control panel successfully automated the silage handling system including the silo unloader and bulk feeder. Efforts to construct a low horsepower high volume silo unloader were unsuccessful. Hay pellet press and instrumentation for it are under design and construction. In the mow-unloader study a new design was developed providing for distribution when filling as well as for removal from storage. A bulletin on self-feeder tower silo work is in preparation. A self-feeder hay barn was emptied by the herd without human assistance. Plans for the barn are available.

USEFULNESS OF FINDINGS:

Harvesting---Tungsten carbide coated sickle sections improved performance and reduced maintenance. Tractor tire performance and legume recovery information should be of value to various manufacturers and scientists. Pinpointing the losses from different components of harvesting systems should improve machine design.

Processing---Data on haylage storage should provide a basis for design of efficient storages, machines and procedures. The influence of drying temperature on quality of hay will assist in defining drying requirements. Equations for air flow in bales should assist in design of systems. Drying efficiency can be improved by a recirculation of heated air in wagon systems. Results in hay wafer study and reaction force should be helpful in continued studies of unstable wafers.

Storing---In mechanized baled hay storage, a 65% reduction in labor can increase the farmers' efficiency. Pneumatic tube conveying of chopped hay could be valuable in terms of reduced labor costs.

Feeding---Conveyor feeding systems, bin unloaders, silo unloaders and related equipment as well as self-feeding structures all contribute to greater efficiency of the farmer.

Title: PROJECT NEM-22 - FACILITATING THE MARKETING OF SEED THROUGH
IMPROVED TESTING PROCEDURES

Leader: J. L. Newcomer, Chairman, Regional Technical Committee

Cooperators: Maine, Maryland, Massachusetts, New Hampshire, New Jersey,
New York (Geneva and Ithaca), Pennsylvania, and Rhode Island
Agricultural Experiment Stations, F.C.R.B., V.O.R.B., and
S.E.S.D., A.R.S., USDA, and B.S.B., A.M.S., USDA

Field plantings were made with 16 lots of alfalfa seed to check on the validity of techniques developed in the laboratory, greenhouse, and growth chambers. Four lots were authentic samples of Vernal, Narragansett, DuPuits and Caliverde. Twelve samples were distributed as "unknowns" with the following information. These "unknowns" were to be either pure seed of the above named varieties or mixtures of seeds of these varieties. None of these mixtures was to contain seed of more than two varieties and no variety in the mixtures would occur in proportion of less than 10%. Sub-samples of these seeds were distributed to five stations in the region. Maine, Maryland, Pennsylvania, New York, and Rhode Island made uniform space plantings. Notes were taken during the summer on flower color and date of bloom. After the plants were cut in the fall and had made sufficient regrowth, notes were taken on plant height, plant type, and stem diameter. With the field data it was relatively easy to distinguish the nondormant types, DuPuits and Caliverde, from the dormant types, Narragansett and Vernal, and to make an accurate estimate of the proportion of these types in the "unknown" lots. On the other hand, it was difficult to distinguish DuPuits from Caliverde or Narragansett from Vernal. There was relatively little interaction between varieties and locations. Thus, field tests could be conducted for the whole region at one location. It seemed advisable, however, to conduct tests at two locations to insure against stand failures and unfavorable weather.

Estimate of the components of the 1961 NEM-22 mixtures based on information obtained in the field at four locations in the northeast:

Sample No.	<u>Estimate of Components Found</u>	<u>Proportion of Plant Desired</u>
1		100% Caliverde
2		100% DuPuits
3		100% Vernal
4		100% Narragansett
5	90% DuPuits - 10% Vernal	100% DuPuits
6	50% Caliverde - 50% Vernal	50% Vernal, 50% Caliverde
7	70% Caliverde - 30% Vernal	40% Narragansett, 60% DuPuits
8	30% Vernal - 70% Narragansett	100% Vernal
9	30% Caliverde - 70% Vernal	75% Vernal, 25% DuPuits
10	90% DuPuits - 10% Narragansett	75% DuPuits, 25% Caliverde
11	25% Caliverde - 75% Narragansett	75% Narragansett, 25% Caliverde
12	90% DuPuits - 10% Vernal	25% Vernal, 75% DuPuits
13	20% Vernal - 80% Narragansett	75% Vernal, 25% Narragansett
14	20% DuPuits - 80% Narragansett	10% Caliverde, 90% Vernal
15	67% DuPuits - 33% Narragansett	35% Narragansett, 65% Caliverde
16	10% DuPuits - 90% Narragansett	10% Caliverde, 90% Narragansett

Greenhouse and growth-chamber tests were conducted in New York and Pennsylvania.

In tests at New York, plants were grown under five different conditions and were classified as to five different physiological and morphological characteristics. Plants were grown with photoperiods of 12-1/2 hours. The temperature during the light period was 70 F and during the dark period 40 F. Two light intensities, 2,200 footcandles and 1,300 footcandles, were used. Caliverde was easily distinguished with these tests.

In another test, the seed was planted in flats with half of the soil treated with Phosfon-D. Again, Caliverde responded differently.

Efforts are being made to get a higher percentage of the plants into bloom in a shorter time. It has been possible in the growth chamber to bring half of the plants into bloom in seven weeks, thus allowing classification of these plants on the basis of flower color.

Twelve-day-old greenhouse seedlings were scored for serration of the unifoliate leaf. In this test Vernal was separated.

Factors affecting the blooming of forage plants under artificial light were studied. In order to obtain blooms in a short time, it was necessary to supplement the light from fluorescent tubes with incandescent bulbs. A constant temperature of 80 F with two photoperiods per 24-hour day increased the percent of plants in bloom. With the best treatment used, it has been possible to have buds or bloom on 64% of the alfalfa plants, 45% of European birdsfoot trefoil, 56% of the red clover, and 24% of the timothy plants in five weeks.

In orchardgrass and timothy, late varieties tended to produce fewer tillers than early varieties.

Other work in New York included the use of various chemicals and hormone sprays on seedlings, soil chemical and fertilizer treatments and disease resistance tests.

In Pennsylvania, the rooting habit and leaf serrations of alfalfa, plant serology, and hemiglutinins were studied.

In Maryland, the roots of germinating seeds of alfalfa varieties are being studied for differences in amount of fluorescence under ultra-violet light.

Work Planned for 1962

Winter survival notes will be taken on the 1961 plantings in the spring of 1962 and these plantings will be terminated.

In the field new planting of mixtures of varieties of alfalfa seed will be made to check the accuracy of greenhouse and growth chamber tests. Seed of 10 varieties will be used. Twenty "unknowns" will be made. The 10

varieties and only 10 "unknowns" will be tested in Maine and Pennsylvania. The 10 varieties and the other 10 "unknowns" will be planted in New York and Maryland. All samples will be tested in the greenhouse and growth chambers in New York and at other locations desiring to work on the same.

Pennsylvania will continue the correlation of climate factors and alfalfa plant response at different locations, the exploratory study of using such techniques as serology, chromatography, electrophoresis, hemiglutinins, spectrophotometry and fluorometry to identify alfalfa varieties.

Maine and Maryland will cooperate with field plantings.

Title: PROJECT NE-24 - THE NUTRITIVE EVALUATION OF FORAGES

Leader: A. M. Smith, Chairman Regional Technical Committee

Cooperators: The 12 Northeastern States and The U. S. Regional Pasture Research Laboratory, D.C.R.B., ARS and cooperative State Experiment Station Service.

Efforts to relate date of first harvest and its nutritive value were made at Delaware, Maine, Maryland, New Hampshire, New Jersey, New York, Rhode Island, Vermont, and West Virginia. Various management, environmental and plant breeding factors which might influence this relationship were emphasized as follows: 1) level of nitrogen fertilization (Del., Me., N.H., N.J., R.I., and W. Va.); 2) method of preservation (Del., Md., N.J., Penna., and Vt.); 3) geographical location within a state (N.H., N.J., N.Y., and Vt.); 4) forage varieties within a species (Del., Md., N.H., N.Y., R.I., and Vt.).

In an effort to develop more accurate and time-saving methods for the nutritive evaluation of forages considerable effort was expended in the study of: 1) metabolism of forage nitrogen (Delaware), 2) determination of digestibility by use of the dacron-bag technique (Massachusetts), 3) effect of species difference and rate of intake upon pH and concentration of volatile bases and acids (Massachusetts), 4) relationship of in vitro cellulose fermentation to in vivo digestible energy or dry matter values (West Virginia, Massachusetts, Maine, and New Jersey), 5) comparison of the chemical composition of forages with digestibility data on these forages as obtained from other cooperating groups (U. S. Regional Pasture Research Laboratory), 6) use of detergents as a method of feed fractionation for predicting the nutritive value of forage (Dairy Cattle Research Branch, A.R.S., USDA), 7) production response to specific forage and forage mixtures (Maine, Maryland and Vermont), 8) determination of acceptability as an indicator for forage nutritive value (Delaware, Maryland, New Hampshire, New Jersey, New York, Pennsylvania, Vermont and West Virginia).

Although the data obtained from the various contributing projects continued to emphasize the importance of date of harvest upon the nutritive value, the importance of acceptability of the various forages and other factors received considerable attention in order to determine the actual productive potential of the forages in question. This past year more forage species were investigated than ever before. Data were obtained using several varieties of alfalfa, orchardgrass, timothy, birdsfoot trefoil, reed canarygrass, Bermuda-grass, brome-grass, tall fescue, Kentucky bluegrass and Sudangrass. In general, this year's work continues to support the data reported last year, that as date of harvest of first-cut forage is delayed, the digestibility of dry matter declines approximately one-half percent per day. It should be noted, however, that in most cases there is considerable variation in the latter part of the season depending upon such factors as forage species involved, amount of rainfall during the growing season, geographical location, rate of fertilization and other environmental factors.

The data, although still limited in volume, continue to indicate that acceptability of forages is influenced by date of harvest.

There still exists a great need for continued study in this field because there is considerable variation as may be seen in the West Virginia data. These workers reported that in four of the forages studied, voluntary intake was positively correlated (significant at the 1% level) with digestibility of dry matter; for one forage, the correlation was significant at the 5% level, and for the remaining three forages the correlation was not significant.

The importance of the results of the studies under this project is evidenced in altered recommendations by many states on forage harvesting. These have been widely accepted by the farmers of the Northeast. Several of the major feed companies have used the date of harvest information as the basis of their grain feeding recommendations. The date of harvest concept has been publicized in several of the more popular farm magazines.

Title: PROJECT NE-28 - BREEDING AND EVALUATION OF IMPROVED VARIETIES
OF FORAGE CROPS ADAPTED TO THE NORTHEAST

Leader: J. L. Starling, Chairman Regional Technical Committee

Cooperators: Connecticut (Storrs), Delaware, Maine, Maryland, New Hampshire, New Jersey, New York (Cornell), Pennsylvania, Rhode Island, Vermont, and West Virginia Agricultural Experiment Stations; F.C.R.B., A.R.S.; C.S.E.S.S.; USDA and A.S.T.A.

PROGRESS OF WORK AND PRINCIPAL ACCOMPLISHMENTS:

Breeding and evaluation were conducted on four major forage species in eight states. Sites of work and principal accomplishments are summarized for each species.

Alfalfa (Connecticut, Maine, Maryland, New York, Pennsylvania, Rhode Island, and West Virginia)---Progenies of selected clones were evaluated for yield and persistence. Recently formulated synthetics and varieties were tested in seven states under two managements reflecting cutting stress. Broadcast plantings of single crosses, double crosses and synthetics among selected clones were made in three states. Seed for this series of tests had been produced under cage in New York and in California.

In preliminary results wilt resistant Narragansett, wilt resistant Flemish and high seed set Narragansett yielded comparably to the parental varieties.

Bromegrass (Maryland, New Hampshire, New York, Pennsylvania, and West Virginia)---Seed was harvested for regional testing from clones selected for improved aftermath and disease resistance. Selfed seed was produced from certain clones for use in future studies on breeding methods. In variety and management trials established in 1960, several new synthetics, Pa-58-2, NY-57-2, and NH-Syn-F, performed well. Tests of new polycross progenies were successfully established in two states in 1961.

Orchardgrass (Maryland, New York, Pennsylvania, and West Virginia)---First generation seed was produced from 11 recently formulated synthetics which represent an effort to produce both regionally and locally adapted varieties. Sixty-six clones contributed by several states were classified for maturity, rated for assorted characteristics and seed was harvested for test of polycross progenies. Selfed seed was produced from these 66 clones and from 10 additional clones for future breeding studies. Experimental synthetics were evaluated under variable managements in four states. Several synthetics yielded higher than check varieties.

Timothy (Maine, New York, and Pennsylvania)---Selfed seed was produced for projected work in breeding. Polycross progenies of clones of three different maturity groups were harvested for the third year. These clones continue to show significant differences in yield, dry matter content and maturity which are important factors in the development of higher quality forage.

Approximately one-third of the project's annual budget was allocated for the production of seed materials. These include seed of the experimental synthetics in orchardgrass, selfed seed of brome grass, orchardgrass and timothy, and the materials developed in alfalfa. Seed of the alfalfa crosses and synthetics used for plot testing was produced under cages in California through contract arrangements negotiated by New York.

USEFULNESS OF FINDINGS:

The orchardgrass synthetics, by virtue of methods followed in their constitution, and the alfalfa hybrids and synthetics offer an exceptional opportunity to gain valuable information on breeding methodology while efforts are devoted toward the development of improved varieties from the parental clones involved. To date, few studies have been directed to the problem of variety synthesis in forage crops. Results of trials of these materials should be of considerable significance to all forage breeders.

Results from all trials of polycross progenies and synthetics aid in determining productivity, quality, and region of adaptation of new breeding materials. Final tests of experimental synthetics represent the culmination of 20 or more years of breeding research in the Northeast in alfalfa, brome grass, orchardgrass, and timothy. The evaluation of these synthetics under several managements is providing more complete knowledge of yield potential, tolerance to diverse and adverse conditions, and an opportunity to study the effects of maturity on quality.

WORK PLANNED FOR NEXT YEAR:

Data will be collected from orchardgrass, brome grass and alfalfa trials established in 1960 and from alfalfa hybrid and synthetic trials and brome grass polycross trials established in 1961.

New plantings of orchardgrass and brome grass polycross progenies will be made and parental clonal nurseries will be established in states testing progenies.

Work will continue in developing additional alfalfa hybrids and synthetics. Syn-2 nurseries will be established for 11 orchardgrass synthetics. Increased efforts will be made to produce selfed progenies in brome grass, orchardgrass, and timothy.

Work will be initiated in brome grass to incorporate genetic markers into selected lines. Markers will be used in genetic studies and in evaluating the consequences of various crossing procedures among clones.

Title: PROJECT NE-29 - MANAGEMENT AND PRODUCTIVITY OF PERENNIAL GRASSES

Leader: C. S. Brown, Chairman Regional Technical Committee

Cooperators: The 12 Northeastern Agricultural Experiment Stations, Forage and Range Research Branch and C.S.E.S.S., A.R.S., USDA

Uniform defoliation practices were employed by each station. Four grasses, orchardgrass, reed canarygrass, brome grass and timothy were included. Varietal comparisons involving some recently released in the northeast were also included. Each participating station maintained records of air and soil temperatures, soil moisture, and precipitation.

The 1961 season added to data of first-crop yields at different stages of maturity. Yields were highest at early or past bloom. The patterns of yield shown by brome grass and timothy were fairly uniform, the early head stage usually 65 to 70% of the yield at early or late bloom. Reed canarygrass, on the other hand, often attained its maximum growth at the early-heading stage. Increased aftermath production compensated in part for sacrifices in first-crop yields by early harvested grasses. Total yields for the season still remained highest for the early-bloom or past-bloom stages, but yields of the pre-joint and early-head treatments were often 70 to 80% of the maximum yields.

An unusually vigorous aftermath recovery was reported for Climax timothy by Pennsylvania, Vermont, and Maine. Brome grass did not show similar recovery. Following pre-joint harvest, daily growth rates for timothy were approximately twice those of brome grass.

Brome grass and timothy were unusually injured by early harvesting, with brome grass the more sensitive. In extreme cases stands were greatly depleted and invaded by weeds. Close clipping of the first aftermath, combined with high nitrogen fertilization, often aggravated this thinning of stands. Orchardgrass has been outstanding in its superior tolerance to a range of harvest practices.

The effect of harvest schedule on grass longevity is of major economic importance and must be considered in connection with seasonal digestibility data collected under NE-24. Results of NE-29 clearly indicate that untimely harvesting may shorten life expectancies of certain grass species. Management systems must compromise yield, quality and longevity for economical use of perennial grasses in the Northeast.

The potential usefulness of grass management research is exemplified by the unexpected results with timothy. It appears that an early defoliation at a pasture stage may shift the major hay crop to the first aftermath and help spread the harvesting period for quality hay.

The pronounced sensitivity of brome grass to early harvest, along with the superior tolerance of orchardgrass to defoliation treatments, suggests that the roles of these species should be carefully examined in future forage planning.

Title: PROJECT NE-43 - PROFITABILITY OF ALTERNATIVE FORAGE SYSTEMS FOR
NORTHEAST DAIRY FARMS

Leader: J. K. Pasto

PROGRESS OF WORK AND PRINCIPAL ACCOMPLISHMENTS:

Delaware, Maryland and New Jersey collaborated on research on hay drying, and issued a regional bulletin.

New York and New Jersey made business analyses of various forage practices on dairy farms. Emphasized was the high, direct relationship between milk produced per cow and crop yields, because of the additional roughage made available. In West Virginia a serious factor limiting alfalfa yields is the weevil. Further analysis is being made there to determine and analyze the physical and economic relationship of forage production.

Connecticut research shows that careful selection of crops, their combination in the rotation, and more intensive use of fertilizer can greatly reduce the per acre costs of net energy from forages on most farms. Increase of output from a given land area remains as the least expensive way to procure additional forage.

Rhode Island has completed the three-year experiment comparing the annual forage rotations with conventional grass-legume rotations. This analysis has pointed out several problem areas. (1) Labor to care for cattle becomes a limiting factor as land productivity and dairy cattle productivity increase. (2) Timing of forage production raises management problems.

Farms with a combination of hay, grass silage and corn silage had significantly higher milk production per cow than those with hay alone, or those with hay and grass silage. This emphasizes again the importance of size in reducing forage production and other farm costs.

USEFULNESS OF FINDINGS:

Research accomplished under this project has shown that farmers follow a great variety of forage production, harvesting, storage, and utilization practices, even when the resources they command are quite similar. Profitable and unprofitable practices have been identified, and this information is being used by extension personnel. Adoption of profitable practices by farmers means more economical milk production which in the long-run benefits consumers.

PASTURE RESEARCH AT STATE STATIONS

CONNECTICUT (STORRS)

Title: FORAGE EXPERIMENTS

Leaders: B. A. Brown, E. R. Larssen, and R. I. Munsell

(a) Varieties of Alfalfa: The chief cause of short-lived stands of alfalfa at this Station has been "bacterial wilt". Different lots of seed of the same variety have varied in the prevalence of this disease. However, in recent years there have been marked differences in the ages at which susceptible varieties were seriously affected. For example, DuPuits and Alfa have had appreciable amounts of wilt and rapid thinning in the second-harvest year while Narragansett on the same areas was not similarly affected until the fourth season. Entire stands of Narragansett appear to have diminished vigor without the definite symptoms of wilt manifested by DuPuits or Alfa.

Williamsburg, Lahontan, NK501 and N9-502 were also found too susceptible to wilt for Connecticut. Atlantic, Vernal and most of the unnamed strains have not shown symptoms of the disease and have maintained their stands longer than any of the susceptible varieties.

(b) Rates and Sources of Lime for Legumes: In earlier pot and plot experiments the beneficial effects on perennial legumes of liming soils close to pH 7.0 were quite marked, especially with alfalfa, but also with Ladino clover and trefoil. In some tests the benefits did not become apparent until the third or later years after seeding. Besides prolongation of the life of a stand, also involved is the problem of establishment of a legume - or other sensitive crop - on strongly acid soils not limed till shortly before planting.

The two current experiments include 1958 and 1959 seedings of alfalfa-timothy, Ladino-orchardgrass, and trefoil-timothy on previously unlimed, strongly acid (pH 5.2), infertile Paxton very fine sandy loam soil, limed at several rates and with two carriers just before drilling the seeds. Liberal PKB fertilization was practiced on all plots.

In 1961, the third-harvest year of the 1958 seedings, there were still only slight indications of any better stands or yields from increasing the rates of dolomitic limestone (30-20) from two to six tons per acre or from substituting 1.25 tons of hydrated lime for 1.75 tons of the dolomitic limestone. This statement applies also to the 1959 seedings for which limestone rates varied from two to eight tons per acre.

(c) Frequency of Phosphatic Applications: The 1961 season was the second-harvest year of this 196-plot project with a Vernal alfalfa-timothy seeding in 1959, involving seven rates of dolomitic limestone (1 to 16 tons) and seven rates of 46% superphosphate (200 to 1600 pounds), on Paxton very fine sandy loam soil with a pre-treatment pH of 6.0 and a "medium" level of available phosphorus. The first cutting acre yields of dry matter varied only from 5500 to 5800 pounds, the second cutting from 2500 to 2800 pounds, and the totals from 8000 to 8400 pounds. These values add to the previously accumulated data indicating the ineffectiveness of frequent applications of phosphates to stands of perennial legumes. It appears probable that soluble phosphates may be added before seeding in sufficient amounts for the duration of the stand without losses in efficiency. If borax were also applied before planting only carriers of potassium would be needed annually.

(d) Effects of Nitrogen Rates and Irrigation on Orchardgrass and Timothy: In 1961 from 125 to 750 pounds of nitrogen (N) from ammonium nitrate was pro-rated equally to five cuttings of orchardgrass with and without irrigation. During May and June the grass had marked symptoms of N deficiency on the 125- and 250-pound plots but the deficiency was not apparent later in the season when growth was much less rapid.

Total yields of dry matter for the season exceeded 10,000 pounds per acre and were not increased by more than 250 pounds of N. Irrigation to provide a total of 1.5" per week, including rain, increased yields significantly with the four lower, but not with the two highest rates of N.

The total nitrogen concentration in the dry matter increased from 2.4% with 125 pounds of N to 3.5% where 750 pounds of N were applied.

Nitrate N in the forage increased with increasing rates of fertilizer N, reaching a maximum of 0.48%, a value about one-third the level considered dangerous to livestock. Three cows were fed all of the high N grass they would consume for three days without any apparent ill effects.

During May and June timothy was treated and harvested twice at the same times as the orchardgrass. Further experimentation with timothy was discontinued because it lodged, rotted at base of the stems and much of it failed to recover after the second mowing.

(e) Effect of Population on Corn Yields: Corn in very thickly planted stands grows more rapidly for a few weeks than it does in normal stands. Experiments at Storrs during the past three years have shown that, after about August 1, populations of over 75,000 plants per acre do not yield more dry matter than much thinner stands. The thick stands fall behind toward the end of the season.

Stands of over 50,000 plants were very susceptible to lodging during windy storms. On July 22, 1961, a 200,000 plant stand fell flat without any rain or much wind. At that time the corn contained 93% water and yielded only 5,000 pounds per acre of dry matter.

The largest yield of dry matter at the normal dates of harvesting silage was 16,700 pounds per acre in 1960 and was obtained from 29,000 stalks in an 18" x 8" planting. In 1961, the corresponding values were 14,800 pounds from 41,900 plants in an 18" x 5.75" spacing. In both years, fertilizer nitrogen was added in amounts beyond the needs of the crops. No irrigation was provided and in 1961 the growth was slightly curtailed in August by three weeks with only 0.23" of rain.

Title: WEED CONTROL IN FORAGES

Leaders: R. A. Peters and H. C. Yokum

A three-year study of the biology of yellow foxtail (Setaris lutescens) was concluded. Basic knowledge of the growth characteristics of this common, summer annual grass will assist in a more intelligent use of herbicides for its control.

Yellow foxtail was found to germinate over a protracted time interval. There was, however, a difference of only a few days in time of blooming which indicates that daylength is the controlling factor in flower production.

The vegetative development in the field was strongly influenced by density of stand. Plants spaced 12 inches apart produced over 60 tillers per plant while plants spaced two inches apart produced less than half as many.

Rooting of detached stems may explain why cultivation frequently gives incomplete control of this species.

Title: THE USE OF HERBICIDES IN FORAGE CROP MANAGEMENT

Leader: R. A. Peters

Selective control of old witchgrass (Panicum capillare) in a summer seeding of alfalfa was obtained from a pre-emergence application of neburon, dacthal and diphenamid and from a post-emergence application of 2,4-DB and DNBP. Diphenamid in particular merits further consideration since it controls both annual broadleaf and grassy weeds without injury to the alfalfa.

DELAWARE

Title: CONTROL OF INSECTS AND MITES ON SOYBEANS, ALFALFA AND CLOVERS

Leaders: W. A. Connell, D. MacCreary and D. F. Bray

Effective control of alfalfa weevil without residue at harvest was obtained with heptachlor granules applied before November 15 at a rate of one pound per acre. These tests were carried out on one-acre plots using normal farm equipment and practices. Telodrin (Shell SD-4402) applied as a spray on December 6 at 0.25 pound per acre was equally effective. Phorate granules, at rates of up to 4 pounds per acre applied December 6, and dieldrin granules at one pound per acre November 15, as well as at 0.5 pound per acre on March 17, were less effective. Residue data were obtained for all these treatments.

Further work on the evaluation of Telodrin is in progress, as well as a comparison of heptachlor granules.

A study of sampling methods is comparing sweeping methods with egg counts and comparing data obtained from night-time sweeping with those from day-time sweeping.

A portion of the larvae injuring the first cutting hatch from overwintered eggs while the remainder are from spring-laid eggs. An attempt is being made to assess the relative amount of damage to the first cutting from each of these components of the larval population.

Title: A STUDY OF THE INFLUENCE OF CUTTING HEIGHTS, NITROGEN FERTILIZATION AND IRRIGATION ON PLANT SURVIVAL AND THE ROOT AND DRY MATTER YIELDS OF ORCHARDGRASS

Leader: W. H. Mitchell

Mortality in S-37 orchardgrass stands following mid-summer harvests prompted a search for the responsible factors. It was observed that this mortality was associated with nitrogen fertilization, close clipping, and reduced root systems and occurred following the second as well as the third harvest during the season.

The present study involves harvest heights of 1" and 3", nitrogen fertilization with ammonium nitrate, urea, and urea-formaldehyde and two levels of irrigation.

Following the first harvest, regrowth was largely from stem elongation where the low nitrogen and three-inch cutting treatments had been used. With high nitrogen and one-inch cuts, regrowth was largely from basal buds, many of

the stem primordia having been removed by the harvest. Square-foot counts of severed stems showing no regrowth were 38, 25 and 11 for 200 lbs., 100 lbs., and no nitrogen treatments, respectively. Similar counts made in plots cut at one and three inches showed no regrowth from 31 and 18 severed stems, respectively.

Following the second harvest a significant loss of stand was noted under high nitrogen, irrigation, and close cutting treatments. These factors appear to be additive with height of cut playing the most significant role.

Title: A STUDY OF THE FACTORS INFLUENCING ALFALFA HAY PRODUCTION IN
DELAWARE

Leaders: W. H. Mitchell and W. E. Hesseltine

Alfalfa hay samples representing the first and second harvests in 1961 were obtained from 65 farms. Information was collected covering data of harvest and rain damage. Prior to preparation for crude fiber and crude protein determinations several staff members and Dairy Herd Improvement Association Supervisors made estimates of the levels of these components. The estimates were compared with chemically determined values.

Standard deviations ranged from 2.1 to 2.5 for percent crude protein and from 4.5 to 5.0 for percent total digestible nutrients.

Rain damage generally resulted in lower total digestible nutrient values with no significant changes in crude protein levels.

With each day's delay in harvest after May 1 the level of total digestible nutrients in the first harvest dropped by .3% as compared to .49 in a similar survey conducted in 1960.

Title: NUTRITIVE VALUE OF SORGHUM SILAGE

Leaders: G. F. W. Haenlein, R. L. Salsbury, W. H. Mitchell

Departments: Animal & Poultry Science, Agronomy, and
Agricultural Engineering - University of Delaware

Ambercane (Sorghum vulgare var. saccharatum L.) silage was compared with corn silage in a double-reversal experimental design, using 20 Holstein cows to determine its value for milk production. Consumption of fresh silage was higher in the Ambercane than in the corn groups; on a dry basis, there was no apparent difference in consumption. Ambercane silage-fed cows gained more weight than those on corn silage, but they produced significantly less milk, milk fat, and solids-not-fat. Percentage milk fat was not significantly

different; however, solids-not-fat percentage was significantly lower in the Ambergane group. Digestibility of the silages was determined in experiments with 8 cows, 12 sheep, and 8 rabbits. Nutrients in Ambergane silage were less digestible than those in corn silage. The correlation found between silage crude protein content and digestible protein content was $r = 0.75$. Digestion coefficients were significantly correlated between rabbits and sheep for both silage dry matter and protein ($r = 0.98$ and $r = 0.93$, respectively).

MAINE

Title: MANAGEMENT OF ALFALFA MIXTURES

Leaders: C. S. Brown and R. F. Stafford

The alfalfa-Ladino clover and alfalfa-trefoil mixtures sown in 1960 (1960 Annual Report, page 62) were subjected to two-cut, three-cut, and four-cut systems of harvest. Greater frequency of cut depressed alfalfa and increased the spread of Ladino clover. By fall 1961, the four-cut system had resulted in a Ladino content of approximately 30% in contrast to less than 5% in the two-cut or three-cut systems. The alfalfa-trefoil mixtures showed little response of trefoil to cutting frequency, which remained uniformly low throughout the season.

Title: UPTAKE OF TOPDRESSED POTASSIUM BY ALFALFA AND HIGH NITROGEN TIMOTHY

Leaders: C. S. Brown, R. F. Stafford and P. N. Carpenter

The experiment seeded at five locations in 1960 (1960 Annual Report, page 61) was topdressed at different times with muriate of potash ranging from 0 to 300 lbs. K_2O per acre. A three-cut system was employed. Seasonal uptake of K and the effect of K rate on mineral content were determined.

The K content of timothy equalled or exceeded that of alfalfa in most cases. Mean values for the five soils and ten K treatments were: First cut - timothy 2.55, alfalfa 2.62; second cut - timothy 2.67, alfalfa 2.21; third cut - timothy 2.48, alfalfa 2.26 K.

Crop removal of K was considerably greater for alfalfa than timothy on most soils, coincident with higher yields. Crop removal at the 300 K_2O rate, averaged for the five locations, were as follows: timothy 184, alfalfa 251 lbs. K per acre.

Single massive applications of K had surprisingly little effect on P, Ca, and Mg content, in spite of substantial increases in K content. Depressed Mg content was the only effect noted and then only with the alfalfa. A brief summary table is given below, mean of the five locations:

Species	Fertilizer K ₂ O	%, d.m. basis			
		K	P	Ca	Mg
Timothy	0	2.42	.26	.58	.29
	300	2.90	.27	.66	.28
Alfalfa	0	2.21	.29	1.45	.50
	300	3.30	.28	1.50	.39

Title: CHEMICAL COMPOSITION OF MAINE ROUGHAGES

Leader: Bernie E. Plummer, A. S. Getchell, John A. Blease

Work has been continued for the third year on the chemical composition of three varieties of timothy cut at three different stages of maturity. The leaves and stems were separated and analyzed separately. The analysis included moisture, protein, ether extract, crude fiber, ash, N F E, lignin, cellulose and carbohydrates other than lignin and cellulose. This completes three years' study. Results will be summarized.

At the present time calcium and phosphorus determinations are being made on a variety of forages to determine how much of these elements are being furnished dairy cows in the roughages they receive.

Title: HARVESTING PROBLEMS ASSOCIATED WITH HIGH YIELDING FORAGE

Leaders: R. J. Rowe and C. M. Milne

This study, begun in 1958, has the primary objective of determining the effect of intense fertilization of forage crops on the functional requirements of harvesting machinery. Large area plots of timothy, alfalfa, and red clover were established. The timothy plots were fertilized at three nitrogen levels representing low, normal, and very high rates of application. Experimental data were obtained during 1959, 1960 and 1961. The effect of mechanical treatment and fertilization level on field drying rates has been measured for various machines including flail type forage harvesters and rotary mowers. Measurements of dry matter loss and percent leaf loss have

been made for various harvesting methods involving conventional mowing, raking, and baling, and cutting and pickup with a flail harvester. Some information was obtained on the effect of mechanical treatment and pickup method on the quality of partially field-dried hay as affected by harvest method. These data include chemical analysis for protein and fiber of alfalfa mowed and crushed or cut with a flail harvester followed by raking and baling or pickup with the flail harvester. The applicability of various machines for cutting lodged and tangled crops has been investigated. Results are preliminary.

MARYLAND

Title: FORAGE CROP VARIETY EVALUATION IN MARYLAND

Leaders: R. C. Leffel, A. M. Decker and N. A. Clark

Alfalfa---Twelve varieties of alfalfa were evaluated at College Park during their first year of harvest. Moapa displayed greatest seedling vigor during establishment in the fall of 1960 and severe winterkilling during the winter of 1960-61. Maliani, #2 Alfalfa, FO100, and Alfa were similar to DuPuits in fall seedling vigor; none were as early as DuPuits in date of first bloom in the spring of 1961. Orchies, WL300, N9-504, and N9-502 were similar to Williamsburg in fall seedling vigor; Orchies and N9-502 were earlier in blooming date than Williamsburg, WL300 and N9-504 were comparable to Williamsburg for this character. All varieties exhibited good adaptation and forage production except Moapa.

Red Clover---Thirty-three varieties and local strains of red clover were evaluated at College Park during their first harvest year. None was superior to Chesapeake; most were inferior. Chesapeake exhibited exceptional vigor and persistence. All 24 local strains were comparable to Chesapeake in dates of bloom.

White Clover---Six varieties of white clover were evaluated at College Park during their first harvest year. Bohnert, Iowa Synthetic, Pilgrim, and Gigante Lodigiano were comparable in vigor, forage production, and persistence. Louisiana Sl and FC 34634 (Germany) were prolific bloomers and unadapted.

Bermudagrass---A variety test in the Piedmont region of Maryland was harvested for the third growing season. Three varieties were evaluated under two nitrogen levels. Midland continues to be the most productive variety. Greenfield is only slightly less productive but is much more susceptible to leaf diseases. Both varieties were substantially more productive than common Bermudagrass.

Title: RED CLOVER BREEDING INVESTIGATIONS

Leader: R. C. Leffel

Agronomically desirable clones have been evaluated for "pseudo-self-fertility" and for resistance to mildew. Single crosses have been made to study the inheritance of "pseudo-self-fertility" and to transfer mildew resistance to much of the breeding material. Sterility allele segregation among S_1 progenies is being studied currently. Results to date indicate that differences among clones in "pseudo-self-fertility" are repeatable in the greenhouse.

Title: ROOT AND CROWN ROT OF ALFALFA

Leader: O. D. Morgan

Root and crown rot caused by Sclerotinia species has caused considerable damage to alfalfa for a number of years. Two years of experimental plot work on the Eastern Shore of Maryland with chemical soil treatments has produced no control of the disease. Further chemical tests will be tried in 1962, also different rates of fertilizer will be tried to determine what effect nutrition has on control of root and crown rot.

Title: LADINO CLOVER BREEDING, DISEASE, AND INSECT INVESTIGATIONS

Leader: R. C. Leffel

Evaluation of white clover introductions and clonal materials will be completed in the spring of 1962. Persistence and management studies indicate pathological and entomological agents affecting persistence of Ladino clover. Studies in the S_1 generation indicate that sterility alleles segregate in expected ratios. Cytological studies on "pseudo-self-fertility" are in progress.

Title: FORAGE CROP INSECT INVESTIGATIONS

Leader: A. L. Steinhauer

Alfalfa weevil control is still the major forage crop problem. Experiments for the control of alfalfa weevil with fall applications indicated that both heptachlor and dieldrin applied as a granular or as a spray at 1 lb./acre were effective control agents. The most satisfactory time of application was during the first half of November. Residues of heptachlor are avoided if applied prior to November 15, but slight residues result with the use of

dieldrin under the same conditions. Studies indicated that field cured alfalfa and alfalfa cut green and dried artificially tend to exhibit dieldrin residues while frozen green cut alfalfa does not. The reason for this is not yet evident.

Two new chemicals, Imidan and Geigy 30494, used at the rate of 1 lb./acre, gave control of alfalfa weevil equal to 1/4 lb./acre of heptachlor when applied to alfalfa as a spray in the spring.

Studies on a number of common alfalfa varieties indicate there is no significant difference in susceptibility to alfalfa weevil.

Title: THE A. B. C's OF FERTILIZING ALFALFA

Leader: J. H. Axley

Certain facts are inescapable when growing alfalfa. The first is that alfalfa removes a given amount of plant food from the soil. The second is that the amount of plant food removed must be returned to maintain the fertility of the soil. The third supposed fact is that one ton of alfalfa removes 10 to 12 pounds of P_2O_5 and 45 to 50 pounds of K_2O . These values are often given in plant food removal tables, and it is true that alfalfa can remove these quantities of P_2O_5 and K_2O when grown on high fertility soils. However, it has been found that these amounts of P_2O_5 and K_2O are not required for top yields of alfalfa. For example, research conducted in Maryland showed that only 8.8 to 9.2 pounds of P_2O_5 and 30 to 33 pounds of K_2O were needed in each ton of alfalfa. Similar values have also been reported in the literature by Bear of New Jersey and Chandler, Peech, and Bradfield of New York. (Note the close relationship of these values to 100 lbs. of 0-10-30 fertilizer).

The table given below shows the yields of alfalfa in an experiment that has been conducted for six years on a Coastal Plain soil. In this experiment an annual application of 400 pounds per acre of 0-10-30 fertilizer gave better yields than 400 pounds of 0-20-20, or 0-10-20. It can also be noted that 950 pounds annually of 0-10-30 fertilizer did not give as great a yield as 800 pounds of 0-10-30. In fact, 400 pounds of 0-10-30 fertilizer produced almost as much alfalfa as 800 pounds of 0-10-30. A graphical plot of the data indicates that 500 to 600 pounds of 0-10-30 fertilizer should be adequate to produce 6 tons of alfalfa. This means that each ton of alfalfa would need approximately 10 pounds of P_2O_5 and 30 pounds of K_2O from commercial fertilizer. This is true for Coastal Plain soils and soils that have been well fertilized in the past. However, on Piedmont soils that fix larger quantities of phosphorus it would be desirable to use 600 pounds of an 0-15-30 fertilizer or its equivalent per acre instead of the 0-10-30 fertilizer.

Influence of fertilizer on alfalfa yields for 6 years.

Treatment	Time applied	Yield	
		1956-61, average	1961
None		2.09	1.95
1200# 0-20-20	every 3rd year	3.93	4.36
400# 0-20-20	spring	4.06	4.83
400# 0-20-20	fall	4.37	4.74
400# 0-10-30	spring	4.35	5.75
800# 0-10-30	spring	4.62	6.26
950# 0-10-30	spring	4.46	5.88

Not for publication.

Title: THE EFFECTS OF SOURCE OF NITROGEN AND NUMBER OF APPLICATIONS ON DRY MATTER PRODUCTION AND NITROGEN RECOVERY OF MIDLAND BERMUDAGRASS

Leaders: A. Morris Decker and J. R. Miller

Dry matter yields were determined for the second harvest season. Treatments were maintained as previously outlined (1960 Annual Report, page 70).

Yields at Upper Marlboro ranged from 0.88 tons per acre with no nitrogen up to 7.81 tons per acre with 400 lbs. of nitrogen as NH_4NO_3 in four applications. For these same treatments at the Trappe location, yields ranged from 2.19 tons up to 6.92 tons. The plots treated with NH_4NO_3 produced on the average 0.5 tons per acre more dry matter than those receiving urea. The total yields for the season were essentially the same for the two and four applications of nitrogen. This was probably due to the favorable moisture in the early summer compared to the extremely dry weather in the latter part of the growing season.

Title: EFFECTS OF IRRIGATION AND FERTILIZATION OF FIVE FORAGE SPECIES

Leader: A. Morris Decker

Dry matter yields were determined for the fourth harvest season with the exception of the Ladino clover and a few of the high nitrogen bluegrass plots (1957 Annual Report, page 55).

The low tension plots were irrigated three times with a total of 5.18 inches of water. The high tension plots were not irrigated. Therefore, any differences between the high tension and natural rainfall plots should be the result of residual treatment effects from the previous three years. Alfalfa,

tall fescue and Bermuda yields were consistently higher from the natural rainfall plots than for those that received irrigation during the past three years. This was not true for bluegrass.

Yields ranged from 1.10 tons dry matter per acre from non-irrigated bluegrass fertilized with 100 lbs. of nitrogen per acre to 7.04 tons from Midland Bermuda with 400 lbs. of nitrogen plus irrigation. The largest response to irrigation was from Midland followed by tall fescue, bluegrass and then alfalfa. Midland also gave the greatest response to nitrogen followed by tall fescue and then bluegrass. Although alfalfa stands and growth at the two high fertility levels appeared to be superior to the low level there was no real increase in total forage production.

Title: THE EFFECTS OF NITROGEN RATES AND CLIPPING FREQUENCY ON THE PERFORMANCE OF MIDLAND BERMUDAGRASS

Leader: A. Morris Decker

Clipping and nitrogen treatments were continued for the third harvest season as previously outlined (1960 Annual Report, page 70). One ton of lime and an 0-10-20 fertilizer were applied uniformly to the area in early spring.

Dry matter yields ranged from 0.67 tons per acre with no nitrogen on plots harvested seven times to 8.57 tons per acre with 600 lbs. nitrogen on plots harvested three times. In general, yields decreased as the number of harvests increased and the decrease was less as the nitrogen level was increased. The more frequently harvested forage was, however, of higher quality as indicated by total nitrogen determinations and general appearance of the forage. Yields tended to level off between 400 and 600 lbs. of nitrogen per acre. It is interesting to note that yields from the zero and 100-lb. nitrogen levels have steadily decreased during the three-year study while those at higher nitrogen levels have increased. Plots fertilized with 400 lbs. of nitrogen and harvested approximately every three weeks produced 6.74 tons of dry matter per acre. The apparent quality of this forage was also good.

Title: RESPONSE OF ORCHARDGRASS TO VARIOUS SOURCES OF NITROGEN AND THEIR TIME OF APPLICATION

Leader: C. B. Kresge

Nitrogen fertilization of pure grass stands is now recognized by many as a profitable operation. Savings in time and money could be made if the nitrogen were applied at a time which corresponds to a "slack period" in the farmer's schedule. These savings would be dependent, however, on the performance of the nitrogen applied. Will yield response be as great when nitrogen is applied at various times in the fall as in the spring? How are the performances of different nitrogen sources affected by climatic conditions?

Potomac orchardgrass was seeded on a Chillum gravelly loam in the fall of 1960. Nitrogen was topdressed in split and/or single applications at rates of 0, 70, 140, and 280 pounds per acre. Sources of nitrogen used were urea, NH_4NO_3 , $(\text{NH}_4)_2\text{SO}_4$, and a mixture of 75% nitrogen as urea-formaldehyde and 25% as urea. The treatments were or will be applied on one or a combination of the following dates: September 15, October 30, December 15, March 15, and after the first cutting. Soil temperatures at depths of 2 and 6 inches were recorded. Soil samples were taken periodically and will be tested for nitrates and ammonium-nitrogen content. Dry matter yields and nitrogen content of forage will be measured. The investigation will continue, to evaluate possible differences in nitrogen performance under different climatic regimes.

Title: RESPONSE OF BERMUDAGRASS TO VARIOUS RATES OF POTASSIUM AND NITROGEN

Leaders: C. B. Kresge, A. M. Decker, and N. A. Clark

Some yield response of Bermudagrass to potassium application occurred in the latter half of 1961. Little or no response to potassium was obtained in 1960, the first year of the investigation (1960 Annual Report, pages 67-68). Topdressing 42 to 83 pounds of potassium per acre was sufficient to meet the needs for optimum yields at all rates of nitrogen (100, 200, 400, 600, and 800 pounds per acre). A greater response to potassium is expected in 1962 on this Wickham silt loam as it declines in potassium supplying power. Highest yield (7.47 tons of dry matter per acre) in 1961 was obtained with 600 lbs. of nitrogen per acre. However, this was only 0.64 tons greater than that at 400 pounds of nitrogen (6.83 tons) and would not pay for the extra nitrogen applied. Yields of 5.74, 3.91, and 2.04 tons of dry matter per acre were obtained with 200, 100, and 0 pounds of nitrogen per acre, respectively.

The percent nitrogen in harvested forage was 3.4 when 400 pounds of nitrogen were applied and 2.7 at the 200-pound rate. The percent phosphorus in the forage was generally the same under all treatments. Potassium content of harvested Bermudagrass was positively related to rate of potassium applied. Lowest potassium content occurred during growth harvested at the third cutting, several values falling below 1% potassium. This "strain" in midsummer took place despite the fact that potassium was applied after the second cutting.

Title: RESPONSE OF ORCHARDGRASS TO VARIOUS RATES OF POTASSIUM
AND NITROGEN

Leader: C. B. Kresge

Results from 3 years of investigation on pure orchardgrass showed that a 2.4 to 1 ratio of nitrogen to potassium was superior to other ratios applied. Also, use of 200 pounds of nitrogen and 83 pounds of potassium per acre resulted in maximum yields. Plant analysis revealed that the orchardgrass removed more potassium from the soil than was applied. For this reason narrower ratios of nitrogen to potassium were included in the experiment in 1961. Nitrogen rates of 150 and 250 pounds per acre were also applied with the original rates of potassium (1957 Annual Report, page 54). Three cuttings were taken in 1961. The dry matter yields at nitrogen rates of 100, 150, 200, and 250 pounds and 83 pounds of potassium per acre were 1.85, 3.25, 3.36, and 3.74 tons per acre, respectively. When all rates of potassium were compared, optimum yields at any one rate of nitrogen occurred at a 1.8 nitrogen to 1 potassium ratio. The 1.8 to 1 ratio appears to be most desirable when the soil is not capable of a high potassium supplying power. Some soils, such as the Wickham silt loam used in this investigation, have a high potassium supplying power. But, when the soil potassium is constantly removed at high rates, even these soils lose this "power" and the ratio of applied nitrogen to potassium may have to be narrowed for optimum yields.

Title: LEGUME-GRASS MIXTURES IN RELATION TO DIFFERENTIAL NITROGEN
FERTILIZATION

Leader: C. B. Kresge

More experimental evidence is needed on the advantages and disadvantages of applying nitrogen to legume-grass mixtures in which the legume percentage is known. It would be well to know at what point in legume failure nitrogen should be applied. In the fall of 1960, Ladino clover-orchardgrass and red clover-orchardgrass associations were established. Each association was adjusted by seeding and transplanting to contain five different percentages of legume: 10, 20, 30, 40, and 60. Nitrogen, at rates of 0, 25, 50, and 100 pounds per acre, was topdressed in a split application--one-half in

early spring and one-half after the first cutting. In 1961 the dry matter yields were measured for each harvest (4 for Ladino clover mixture and 3 for red clover mixture) and plant tissue was evaluated for total nitrogen content.

Economical yield responses were gained with 50 and 100 pounds of nitrogen when the Ladino clover content was less than about 25%. No significant response to nitrogen in red clover-orchardgrass yields was measured. Very high first cutting yields coupled with drastic changes in legume stand shortly thereafter contributed to the lack of response. Legume percentage in both associations was lowered considerably when 50 and 100 pounds of nitrogen per acre were applied to mixtures with legume percentage above 20%. No definite trends in nitrogen contents of forage existed due to changes in botanical composition of the sward. This investigation will be continued so that responses under different climatic regimes can be evaluated.

Title: SOD SEEDING ESTABLISHMENT TRIALS

Leaders: A. Morris Decker and F. Graham Swain

A series of experiments dealing with the seeding of annual species directly into Midland Bermudagrass and Kentucky bluegrass sod was continued (1960 Annual Report, page 71).

Close-row spacing (8 inches) of sod-seeded rye produced slightly better fall rye production than the 16-inch spacing. However, this difference was not significant, as found in previous years. The 360-pound seeding rate of rye resulted in significantly higher fall production than the 180-pound rate. However, fall yields were too small to justify the extra seed cost. Where a very early fall harvest was made while the rye was only 4 to 6 inches tall yields were generally lower than when the first harvest was delayed until mid-November. A late fall-early winter harvest was not so detrimental as the earlier fall harvest. Best results were obtained with a medium and late harvest schedule. Spring yields of rye were essentially the same regardless of row spacing or seeding rate. None of the treatments resulted in decreased Bermudagrass production. Early spring weeds were reduced with the close-row spacing.

Successful fall establishment of birdsfoot trefoil in bluegrass sod was accomplished by using two new openers developed in cooperation with the Agricultural Research Service, A.E.R.D., Beltsville, Maryland. A disk-type opener was superior to the wing-type and both were superior to the conventional opener of the Grassland Drill. Stands obtained with a packer wheel following the disk opener were superior while the same packer wheel following the wing opener resulted in reduced establishment. There was an advantage to using insecticides in one out of two tests.

Title: INFLUENCE OF SOIL TEMPERATURE ON FORAGE GROWTH

Leaders: A. Morris Decker and N. H. MacLeod

During the past year installation of equipment for the control of three temperature levels in replicated 6 x 15 ft. plots in the field was completed (1960 Annual Report, page 69). Minor modifications are now being made in order that the equipment can better be utilized. Initial studies will be with seedling growth of forage species.

Title: THE EFFECTS OF CLIPPING HEIGHTS AND FREQUENCY OF HARVEST ON THE PERFORMANCE OF MIDLAND BERMUDAGRASS

Leader: A. Morris Decker

Clipping treatments and fertilizer applications were continued for the second harvest year as previously outlined (1960 Annual Report, page 71). Dry matter yields ranged from 3.52 tons per acre on plots fertilized with 200 lbs. of nitrogen and cut seven times at a four-inch stubble to 9.91 tons per acre with 600 lbs. of nitrogen harvested three times at a one-inch stubble. There was a significant increase in forage production from 200 to 600 lbs. of nitrogen. There was also a significant decrease in forage production as the number of harvests was increased from three to seven. An increase in yield was obtained as the stubble height was lowered from four to one inch. The largest increase was between the four- and two-inch stubble heights. The differences between the two- and one-inch heights were less pronounced, especially at the high nitrogen rate. There was a tendency, however, for the plots with the low stubble cut to have higher weed infestation.

Title: MANAGEMENT STUDY OF SUMMER ANNUALS

Leader: N. A. Clark

Sudangrass, Pearl Millet and a commercial Sorghum-Sudangrass hybrid are being compared under two levels of nitrogen fertilization, two cutting heights (18 and 30 inches) and three stubble heights (2, 4, and 8 inches). Results in 1961 show that the hybrid through an average of all treatments outproduced the Sudangrass and Pearl Millet by .75 tons per acre. The 30-inch height of the hybrid produced significantly more dry matter over the entire growing season than did the 18-inch plant height. This was not true, however, for the Sudangrass and Pearl Millet. The 4-inch stubble height was the most productive for all species.

Title: THE EVALUATION OF PERENNIAL PASTURES FOR LACTATING DAIRY COWS

Leaders: N. A. Clark, A. M. Decker, Jr. - Agronomy Department
R. W. Hemken, R. F. Davis, and J. I. Leslie - Dairy Department

As in 1960, grazing of cereal rye sod seeded into Midland Bermudagrass was initiated in early April, 1961, with annual carrying capacity and milk production at a high level. Productivity of this pasture treatment dropped off in late May and early June as there was a transition from rye to Bermudagrass in the sward. Carrying capacity increased as the Bermudagrass became dominant in the sward and under a system of frequent clipping milk production was maintained at a high level.

Orchardgrass fertilized at 100, 200, and 300 pounds of nitrogen per acre was compared with orchardgrass grown in association with Ladino clover as pasture for lactating dairy cows. Dry matter production for the treatments having the two high rates of nitrogen was double that of the orchardgrass-clover pasture, and the low nitrogen treatment was intermediate. Carrying capacity followed this same pattern. Individual cow milk production, however, was highest for the orchardgrass-clover pasture and decreased with increasing rates of nitrogen on the pure orchardgrass pastures.

Title: THE EVALUATION OF SUMMER ANNUAL PASTURES FOR LACTATING DAIRY COWS

Leaders: N. A. Clark - Agronomy Department, R. W. Hemken, J. W. Vandersall -
Dairy Department

Piper Sudangrass, Gahi No. 1 Pearl Millet, and a commercial Sorghum-Sudangrass hybrid were compared as summer annual pasture for lactating dairy cows. The pastures were comparable in dry matter production, carrying capacity and milk production; however, there was a significant depression in butterfat production in the cows on the Pearl Millet pasture. This study will be continued in an attempt to characterize the factor or factors causing this fat depression.

Title: GRASS AND LEGUME COMBINATIONS FOR BEEF PRODUCTION

Leader: A. Morris Decker

Two pasture systems (1. rye in a prepared seedbed, orchardgrass-Ladino clover, and Sudangrass; 2. sod-seeded rye, bluegrass, Midland Bermudagrass, rye in prepared seedbed, and sod-seeded rye in Midland) were compared using Angus steers as test animals. Grazing of both pasture systems was begun on March 15 and grazing was continued until December 5 for system number two and September 29 for system one. Beef gains per animal were slightly higher for system one while calculated carrying capacity as well as total days of grazing were higher for system two. Total beef production per acre was 54 pounds higher for system two than for system one. Production from Midland-rye was over 800 pounds of beef per acre. However, when this was averaged with the other two species (bluegrass and rye) the average dropped to 488 pounds per acre.

MASSACHUSETTS

Title: INVESTIGATIONS OF FORAGE CROP INSECTS

Leaders: F. R. Shaw and W. J. Fischang

Introduction---During 1961, population studies were continued of forage crop pests throughout the state. Particular emphasis was given to aphids, leafhoppers, especially Empoasca fabae, plantbugs, particularly Lygus lineolaris, the alfalfa weevil and the meadow spittlebug. We evaluated, in field plots, the effectiveness of some of the newer pesticides suggested for the control of forage crop insects. We supervised the application by growers of fall treatments of dieldrin and heptachlor for alfalfa weevil control. A study of the bionomics of the alfalfa weevil was initiated.

Population Studies---Spring and fall collections were made in each of the counties except Dukes and Nantucket. In the Amherst area, fields varying in composition were sampled weekly to determine population differences in relation to season and forage crops present. Collections consisted of 100-sweep samples using a 15" sweeping net. The relative abundance of the more important species is presented in Table I.

Hypera postica, the alfalfa weevil, was found to occur consistently throughout the state. This insect increased 5-fold over the number collected in 1960, whereas the total number of insects represented a 50% increase above those caught in 1960. The largest single collection included 145 larvae and 16 adults from a field sampled on June 28 in Ashley Falls. Maximum populations occurred in southern Berkshire and Bristol counties resulting in applications of insecticides for their control. Sufficient damage occurred to cause many dairy farmers to apply fall treatments of insecticide to control the weevil in 1962.

The potato leafhopper, Empoasca fabae, was particularly abundant. This resulted in the development of severe alfalfa yellows on second cutting alfalfa which was allowed to mature. The highest field population (1100 per 100 sweeps) occurred in Monson on August 17. Collections of 300-500 per 100 sweeps were common during August and early September. In some experimental plots, populations of as high as 4200 per 100 sweeps occurred. Adults were taken from May 22 until December 3. Leafhoppers, as a group, represented 12.1 percent of the total in 1961 in comparison with 7.5 percent in 1960.

Plantbugs represented 12.9 percent of all insects in 1960 but fell to 6.2 percent in 1961. The tarnished plantbug, representing 40.4 percent of all plantbugs, was again most numerous; the garden fleahopper, Halticus bracteatus was second and the alfalfa plantbug, Adelphocoris lineolatus, was third.

The meadow spittlebug increased from 0.8 percent in 1960 to 2.0 percent in 1961. Late season collections included as many as 312 per 100 sweeps in Walpole, with samples of 100-200 being common throughout the state. Such levels may require insecticidal treatment.

The pea aphid, Macrosiphum pisi, occurred in very large numbers particularly in September. Collections of 2000-6000 per 100 sweeps were common. This insect represented 68.9 percent of all forage crop insects in 1960 and 58.8 percent in 1961.

A study of the predators present shows that in 1960 these insects constituted 2.6 percent of the total, whereas in 1961 they made up 2.1 percent. One obvious difference was the increase in abundance of Orius insidiosus from 6.4 percent in 1960 to 41.3 percent in 1961. Nabis ferus, which was first in abundance in 1960, was third in 1961. Coccinellids were second in both years.

In the Amherst area, 5 fields varying in composition were sampled weekly during the season to determine seasonal fluctuations in populations and the relation of stand composition to insect abundance. As in previous years, aphids reached a peak from late May to mid-June with a smaller peak in early September.

No conspicuous seasonal variations among plantbugs were noted. It is of interest that no explosive increase in Halticus bracteatus populations occurred, as has happened in the past.

During April and May, the only leafhopper present in considerable abundance was Heliochara communis. In June, Macrostelus fascifrons became the dominant species with populations reaching 255 per 100 sweeps. During July and early August, all leafhoppers decreased with Empoasca fabae and Endria inimica being most abundant during late August and early September.

In the Amherst area, small larval populations of Hypera postica occurred from June through late fall with largest numbers being found from mid-June to mid-July.

A field of timothy was found to have lower populations of insects than were found in a field of red clover in three fields having different amounts of alfalfa. Late season aphid populations failed to develop in fields of red clover and of timothy.

Evaluation of pesticides for control of forage crop insects---In order to obtain some preliminary information concerning the effectiveness of some of the newer pesticides or new formulations of older ones, 14 insecticides were applied to alfalfa plots 20" x 40" using compressed air sprayers. Insect samples were taken at 0, 8, 12 and 19 days after the applications were made. Fifty sweeps with a 15-inch net were taken per plot, and the number of insects compared with the average of those found in check plots. The following materials were included:

1. Emulsifiable or sprayable concentrates:

<u>Material</u>	<u>Amount actual per acre</u>
Dimecron	8 oz.
Dibrom	16 oz.
Guthion (cotton formulation)	8 oz.
Guthion	8 oz.
Meta-Systox R	6 oz.
Cygon	8 oz.
Cygon	4 oz.
Kepone	8 oz.
WARF - DDT	16 oz.
Diazinon AC 250	6 oz.

2. Wettable or sprayable powders:

<u>Material</u>	<u>Amount actual per acre</u>
Guthion	8 oz.
Dylox	16 oz.
Bayer 37,344	16 oz.
Bayer 39,007	16 oz.
Hi-Suspension Calcium Arsenate	16 oz.

Following the determination of the insect populations, pea aphids, potato leafhoppers, tarnished plantbugs and alfalfa weevils were compared in treated and control plots. The most effective materials 19 days from application were: Meta-Systox R and Bayer 37,344 for pea aphid and Dimecron for tarnished plantbug and potato leafhopper. While populations of the alfalfa weevil were too small to warrant drawing sound conclusions, Guthion WP and Guthion SC appeared to be the most effective pesticides used.

Fall applications of pesticides for the control of alfalfa weevil--- We applied dieldrin, heptachlor and Telodrin in various formulations on different dates and at different rates to experimental plots to determine their effectiveness in controlling alfalfa weevil in 1962.

We supervised grower application of heptachlor fertilizer mix, granules and spray, and of dieldrin spray and granules for alfalfa weevil control in 1962.

Table I - Census of forage crop insects in Massachusetts 1961.

Insect name or group	Percent of group	Percent of total
Aphids (mainly <u>Macrosiphum pisi</u>)		58.8
Leafhoppers		12.1
<u>Empoasca fabae</u>	39.8	
<u>Macrostelus fascifrons</u>	15.5	
<u>Aceratogallia sanguinolenta</u>	11.9	
<u>Graminella nigrifrons</u>	9.3	
miscellaneous leafhoppers	8.4	
<u>Heliochara communis</u>	6.4	
<u>Draculacephala</u> spp.	4.7	
<u>Endria inimica</u>	3.0	
<u>Paraphlepsius irroratus</u>	1.0	
Plantbugs		6.2
<u>Lygus lineolaris</u>	40.4	
<u>Halticus bracteatus</u>	20.2	
<u>Adelphocoris lineolatus</u>	13.6	
<u>Leptoterna dolabratus</u>	9.7	
<u>Trigonotylus</u>	6.1	
<u>Adelphocoris rapidus</u>	4.2	
miscellaneous Miridae	3.2	
<u>Plagiognathus politus</u>	1.5	
<u>Capsus</u> spp.	1.1	
Beetles		3.6
<u>Hypera postica</u>	38.8	
miscellaneous beetles	15.3	
<u>Popillia japonica</u>	10.0	
flea beetles	8.3	
<u>Tychius</u> spp.	7.9	
<u>Sitona hispidula</u>	6.9	
<u>Ceutorhyncus</u> spp.	6.1	
Elateridae	2.0	
<u>Calomycterus setarius</u>	1.2	
<u>Rhinoncus castor</u>	1.0	
<u>Hypera nigrirostris</u>	0.7	
<u>Sitona flavescens</u>	0.5	
<u>Hypera punctata</u>	0.4	
<u>Sitona scissifrons</u>	0.3	

Table I continued.

Insect name or group	Percent of group	Percent of total
Predators		2.1
<u>Orius insidiosus</u>	41.3	
Coccinellidae	27.8	
<u>Nabis ferus</u>	21.1	
Chrysopidae	5.0	
Syrphidae	2.7	
miscellaneous predators	1.1	
Reduviidae	1.0	
<u>Philaenus leucophthalmus</u>		2.0
Thrips		0.7
Spiders		0.5
Lepidoptera		0.5
Grasshoppers		0.3
Fulgoridae		0.3
Membracidae		0.1
Sawflies		0.1
Other insects		12.8

Title: EFFECTS OF TIME AND HEIGHT OF CUTTING, AND RATES OF NITROGEN
ON YIELDS OF ORCHARDGRASS

Leaders: Mack Drake, W. G. Colby and E. Bredakis

Management studies with high rates of nitrogen applied to the Massachusetts Hardy strain of orchardgrass have shown that recovery is slow and growth is limited after the second cutting (late July). This limited growth appears to be most severe with delayed first harvest combined with low cutting height and high rates of nitrogen applied in the spring plus nitrogen after each cutting. Under these management conditions many of the crowns die in the center, creating a "bird nest" effect and some of these crowns die during the following winter. Early harvest and higher cutting (above growing points) encourage more rapid recovery and growth. It appears that carbohydrate reserves may be reduced in the first cutting by high N x delayed cutting date. However, the effects of this reduction in carbohydrate are not manifested in plant growth until respiration stress develops from high air and soil temperatures in July.

Response of orchardgrass to management was measured in dry matter yields. Treatments included (a) time of cut (early, with 25% of heads emerging and normal, early flower with all heads developed), (b) height of cut (1-1/2-inch and 3-inch); and (c) rates of nitrogen (50 and 100 pounds N/a after each cutting: 130 pounds N/a was applied to all plots before the first cutting).

Yield responses to early cutting, to 3-inch height, and to 100 pounds N/a, each were highly significant. Interactions between height of cut and time of cut; between height of cut and rate of N; and between time of cut and rate of N were highly significant. The sum of cuttings 2, 3, 4, 5 produced 6,275 pounds dry matter/a for early cut at 3 inches with 100 N as compared to 3,120 pounds for normal date and 1-1/2 inch height with 100 N/a.

With 100 pounds N/a the yield response to raising the height of cut from 1-1/2 to 3 inches was 2,140 at early cut and 1,500 pounds/a at normal cut. At the 100-pound N/a and 3-inch height of cut, the response to early cutting was 1,660 pounds/a. At the early cutting date, raising the cutting height doubled the response to N. With the 3-inch height of cut, response to N was 3 times as great for early cut as for normal cut.

NEW HAMPSHIRE

Title: IMPROVEMENT OF WHITE CLOVER

Leaders: G. M. Dunn and R. A. Kilpatrick (in cooperation with the Forage and Range Research Branch, A.R.S., USDA)

Studies were continued on 1958 and 1959 dieldrin and methyl bromide plots. Results from these tests were as follows: (1) dieldrin effectively controlled curculios for 3 years and methyl bromide was equally effective on nematodes; (2) neither treatment appreciably reduced root rot, or had any effect on persistence of the main taproot which rarely lived more than about 2 years; (3) some reduction in root rot occurred in plots treated with both chemicals; (4) dieldrin had no significant effect on yield or persistence in 3 out of 4 tests; (5) moderate yield increases were obtained from methyl bromide and the combination treatment, and stands were somewhat better in these plots in the third harvest season; and (6) methyl bromide effectively controlled both nematodes and weeds, and may have increased plant vigor sufficiently to result in the higher yields.

Syn 2 seed was obtained under cages for 10 diallel crosses for comparison with the Syn 1 in 1962.

Highly significant increases were obtained in dry weight of leaves, stolons and roots from 600 to 1200 f.c. Only slight increases were obtained from 1200 to 1800 f.c. These results were similar to those reported previously for 400, 800, and 1200 f.c. (1960 Annual Report, page 85).

Screening was continued in red and white clover for cold hardiness in freezing chambers.

Sterilized white clover seedlings were grown satisfactorily on agar in test tubes for about 4-5 months, although stolons did not develop on these plants. After this period, most plants gradually weakened and died. Root exudates seem to be involved.

A laboratory method was developed for testing pathogenicity of the meadow nematode, Pratylenchus penetrans, on clover seedlings in test tubes. This method appears promising for evaluation of the possible role of nematodes in the root rot complex.

Cultures of Pseudosphaerulina trifolii produced more spores on 24-hour than on 10-hour daylength. Symptoms developed faster and more prominently on leaves incubated under a short daylength. Five additional hosts (Medicago scutellata, Melilotus alba, Trifolium alexandrinum, T. angustifolium and T. hirtum) were susceptible to the fungus.

Isolates of Stagonospora meliloti varied in growth types and amount of pycnidia and mycelium. Pycnidial production was best on soybean and wheat agars. The data suggested that different races exist in this species.

Title: IMPROVEMENT OF SMOOTH BROMEGRASS, RED CLOVER AND ALFALFA

Leaders: G. M. Dunn, L. J. Higgins, and J. Wright

Syn 1 seed was obtained from 15 diallel crosses among 6 clones, and plots were established for Syn 2 production in 1962. Parental clones were selected primarily for resistance to brown leafspot and good aftermath growth.

Bromegrass mutants obtained to date, chiefly by selfing, include the following: a) chlorophyll deficiencies, b) rolled and folded leaves, c) dwarfs, and d) prostrate growth type.

No homozygous mutants have been identified. Segregating generations have been grown of several mutant x normal crosses, but factorial interpretation is not yet possible. An attempt is being made to obtain homozygous genotypes by additional selfing or sibbing. Studies now in progress or planned with these mutants include: a) emasculation and crossing techniques, b) percent of cross-pollination under bags without emasculation, and c) pollen dispersal and isolation distance required under natural pollination.

Completed calculations of the 10 red clover varieties resulted in Lakeland leading with a total average yield of 6.73 tons per acre for the first season. Pennscott, Dollard, New Hampshire and LaSalle followed. Because sheet ice destroyed over three-fourths of the plots, the second season's yields were not obtained. New trials will be started as soon as enough seed of the New Hampshire selection is obtained from isolated plants in the greenhouse.

Title: FORAGE SYSTEMS

Leaders: E. Cowett, R. Lucey, G. Byers, K. Morrow, R. Andrews and G. Angell

Band seeding of clover-timothy-fescue hay was studied, beginning with the land preparation and ending with barn storage. An 8-acre field of very low fertility was selected. The few bushes and surface boulders on this run-out field were removed, followed by conventional seedbed preparation. Absolute minimum fertility practices ($1/3$ to $1/2$ standard recommendations to farmers) were followed. Band seeding with 400 lbs./acre of 5-10-5 in a band directly below the seed was accomplished by August 7, 1960. The seeding was topdressed with 0-15-30 WB in late fall 1960. A second application of 0-15-30 WB was made after the first cut on July 10, 1961.

Over 2-1/2 tons/acre of hay were harvested from the first cut of hay made during the last week of June and the first week of July, 1961. About 2 tons per acre of hay were harvested the last week of August. Harvest operations consisted of mowing, conditioning, raking (several times), baling (small size bale), and hauling with 3/4 of the hay field finished and 1/4 heat dried finished.

The field curing of large quantities of material in this humid climate posed a serious problem.

NEW JERSEY'

Title: ROOT ROT STUDIES ON ALFALFA

Leader: J. L. Peterson

Several fungi have been found to be associated with root rot of alfalfa in New Jersey. Periodic isolations were made from roots of newly planted and six-year-old alfalfa plants. Species of Fusarium, Rhizoctonia, and Phoma were isolated from young plant roots, Fusarium being the most common isolate encountered. Fusarium sp. and Gliocladium sp. were most prevalent in the older plant roots; species of Rhizoctonia and Phoma were also isolated frequently. Preliminary isolations from the rhizosphere of young and old alfalfa plants showed definite differences in the relative concentrations of various fungi. The population of Fusarium sp., Gliocladium sp. and Phoma sp. was considerably higher in the rhizosphere of the older plants. In addition to these fungi species of Trichoderma, Penicillium, Cephalosporium, Hormodendron, Myrothecium, Volutina and a Verticillium-like organism were isolated most frequently from the rhizosphere of the alfalfa.

The number and kinds of fungi isolated from soil and rhizospheres depend to a large extent on the methods used in the isolation process. The addition of Streptomycin sulfate to media used for the isolation of rhizosphere fungi was found generally to reduce the colony size of most isolated fungi. Particularly advantageous was the ability of Streptomycin to reduce the growth rate of fast growing organisms such as Trichoderma and Fusarium. This allowed for removal of the normally slower growing fungi before the plate was completely overgrown. Nearly all Phycomycetes were inhibited in the treated plates as evidenced by the abundance of species of Mucor and Rhizopus in untreated check plates. The addition of lactic acid instead of Streptomycin to the media allowed growth of the Phycomycetes, but did not reduce the growth rate of Trichoderma or Fusarium species. Additions of both reduced bacterial growth satisfactorily.

Title: CUTTING MANAGEMENT OF SUMMER ANNUAL GRASSES

Leaders: H. E. White and R. W. Duell

Field experiments to investigate the effects of cutting certain Sudangrasses and Gahi pearl millet to various stubble heights at different stages of development were conducted during the summers of 1959 and 1960. A split-split plot experimental design was used both years. In 1959 the plants were cut to 1-, 5-, and 10-inch stubble heights when they reached the joint, boot, anthesis, and dough stages. In 1960 they were cut to 2-, 5-, 10-, and 15-inch stubble heights when they reached the early joint, late joint, early boot, and early anthesis stages of development.

Early cutting, to simulate pasture management, produced lower total yields than late cutting, as in silage management. But early cutting of an early maturing variety, such as Wheeler Sudangrass, particularly at a high stubble height of 5 or 10 inches, produced the most regrowth. Later maturing Piper Sudan produced somewhat less regrowth. No system of management was found to insure satisfactory regrowth of Gahi pearl millet.

Conversely, delaying cutting until the dough stage of later maturing grasses, such as Piper and Gahi, and leaving a short stubble, produced higher yields of these silage-type materials.

Sudangrass is recommended primarily for grazing. Use for silage is a secondary consideration. An early maturing variety then, such as Wheeler, should be used more widely and grazed rotationally soon after the plants are approximately 15 inches tall. But, it should be grazed lightly--- to a 5- or 10-inch stubble, and before plants reach the boot stage of growth.

This management should help to maintain a more continuous and greater supply of quality pasturage throughout the summer when the need is greatest.

Title: MIDLAND BERMUDAGRASS FERTILIZATION

Leader: Robert W. Duell

Midland Bermudagrass plots at three locations have received four rates of 10-10-10, increasing in geometric progression, in split applications since 1957. The rates have been increased each year in an attempt to attain maximum yields, and in 1961 the rates of the previous year were doubled giving annual applications of 1500, 3000, 6000, and 12000 lbs. of 10-10-10/A applied in three equal splits at the resumption of growth and after the first and second of the four harvests. The increase in yield for each rate was statistically significant at each location. Some limiting factor was apparent in that doubling a particular rate in 1961 generally resulted in somewhat lower yields than the single rate in 1960. Moisture did not seem to be appreciably different between the two seasons, and soil tests did not provide an explanation. Minor elements applied to half of the replicates at each location did not affect yields.

Cape May, the southern-most location in the state, produced top yields of over nine tons oven-dry-matter (18,330 lbs.) per acre. At New Brunswick, the northern-most trial, almost nine tons oven-dry-matter (17,428 lbs.) per acre were produced in 1961.

Just as each fertilizer increment increased yields markedly, the contents of protein and potash were also increased. However, percent dry matter decreased markedly and percent phosphorus increased only slightly in the first cuttings of the season and then assumed a negative relationship in the last harvest. The residual effects of the season's fertilizer applications, as measured in the last (fourth) harvest (the only one not topdressed after the preceding harvest), were apparent in the higher yields, protein content, and potash content of the forage from the heaviest fertilized plots only; all other plots were essentially the same in these measurements at this time.

No signs of foliar injury have ever been observed in these tests from the high rates of fertilizer used.

Title: INFLUENCE OF PERCENT CALCIUM SATURATION OF THE EXCHANGE COMPLEX AND FERTILIZATION OF DUTCHESS SOIL ON ALFALFA PRODUCTION

Leaders: R. B. Alderfer and C. H. Ramage

Results of soil analyses are essentially the same as reported in the 1960 Annual Report, page 90, except that at the end of the growing season, all pH measurements were about 0.5 pH lower than in the spring and for all samplings in 1960. High rates of K application (240 lbs. K_2O/A) have increased the amount of extractable K left in the soil at the end of the growing season to a depth of 18 inches.

Average Yields of Alfalfa 1958-61 - lbs. dry matter per acre

Lime Treatment - % Ca Saturation

<u>Control</u>	<u>65%</u>	<u>100%</u>	<u>100%+</u>
5646	7465	7715	8222

Fertilizer Treatments - lbs. $N-P_2O_5-K_2O$ per acre

<u>0-0-0</u>	<u>0-40-80</u>	<u>0-80-160</u>	<u>0-160-240</u>
6150	7535	7596	7793

Title: YIELDS OF GRASS PRODUCED BY HEAVY NITROGEN FERTILIZATION

Leader: C. H. Ramage

Nine-year-old plots of orchardgrass and reed canarygrass were harvested. Phosphorus and potassium have been applied in amounts indicated by soil tests. Lime has been added only once during the nine years, with pH values in March, 1961, ranging from 5.5 to 6.2. There has been some loss of stand on the high-nitrogen orchardgrass plot. Yields in 1961 were as follows:

Dry Matter in Pounds Per Acre of Orchardgrass and
Reed Canarygrass Grown in 1961

		Pounds nitrogen per acre:							
		<u>0#N</u>	<u>50#N</u>	<u>100#N</u>	<u>150#N</u>	<u>200#N</u>	<u>300#N</u>	<u>400#N</u>	<u>600#N</u>
Orchard-									
grass		4974	6823	8710	9992	9860	10,226	9995	9576
Reed canary-									
grass		3994	6004	8170	9670	9079	10,597	10,839	11,310

Title: GRASS FERTILIZATION STUDIES

Leader: R. W. Duell

The six grasses sowed April 1955 and subjected to differential fertilization and clipped to simulate rotational grazing management have been reduced to three species for the purposes of continued comparisons. Although timothy continues to demonstrate vigor and purity of stand in the early May and June cuttings, its performance the remainder of the season is inadequate for comparisons with pasture-type grasses. Reed canarygrass and smooth brome grass plots have been invaded by Kentucky bluegrass and Virginia bluestem to the point where they are no longer representative, in spite of high rates of fertilizers and adequate lime applied annually. Orchardgrass, tall fescue, and Kentucky bluegrass, on the other hand, have maintained adequate stands. A species x fertilizer interaction is apparent in that a treatment for two seasons with NH_4NO_3 as the only source of fertilizer has resulted in a marked reduction in the stand of orchardgrass, but not in the stands of tall fescue nor Kentucky bluegrass. Depletion of soil potassium through crop removal appears to be the primary cause of the loss of stand of orchardgrass.

The higher protein content of the pasturage from plots receiving two applications of 100 lbs. N/A from NH_4NO_3 as against two applications of 1000 lbs./A of 10-10-10 was prominent throughout the season. The lower contents of P and K resulting from the above NH_4NO_3 treatments were rather slight and very marked respectively and persisted as such throughout the season.

In spite of somewhat lower yields resulting from the two applications of 100 lbs. N/A from NH_4NO_3 in comparison with 1000 lbs./A of 10-10-10, the increase in N content of tall fescue and Kentucky bluegrass was sufficient to result in more pounds of N removed per acre by these species from the former treatment in 1961. When fertilized with NH_4NO_3 , all three grasses removed only slightly less P_2O_5 but markedly less K_2O than when fertilized with 10-10-10. The pounds of P_2O_5 and K_2O per acre removed by these grasses (when fertilized with 200 lbs. N/A from NH_4NO_3) from the Nixon loam ranged between 62.5-43.9 and 77.7-55.8, respectively in 1961. These grasses can be further characterized as to percent composition of N, P, K throughout the season under differential fertilization.

Title: PASTURE RENOVATION STUDIES

Leaders: R. D. Ilnicki, M. A. Sprague and R. W. Chase

Studies were conducted under field conditions to evaluate: 1) effective herbicides and herbicide combinations to control existing sod species; 2) the effect of varying tillage intervals, following herbicide application, on soil moisture content and aggregation; and 3) the arsenic content of soil and foliage as a result of the use of cacodylic acid, an organic arsenical.

The first group of herbicides was applied on April 22. The tillage was performed 2, 12, and 22 days after treatment and the entire area seeded to Sudangrass on May 15. Soil moisture determinations were made at the time of tillage and again when seeded. Soil arsenic determinations were made at 2, 5, 10, 20, and 40 days after treatment.

The second group of herbicides was applied June 7. The tillage was performed 2, 7, and 14 days after treatment, and the entire area seeded to Sudangrass on June 21. Soil moisture determinations were made at the time of tillage and again when seeded.

Aggregation samples were collected at seeding time in both studies. Foliage samples were collected at the seedling and grazing stages from control plots and plots treated with cacodylic acid.

The degree of kill was not satisfactory on any of the plots and this is believed to be associated with the high percentage of orchardgrass in the test area. Orchardgrass definitely appears to be more difficult to kill than is bluegrass. The control of bluegrass in all plots was satisfactory.

The varying tillage intervals had no effect on soil moisture content. Soil aggregation was not affected to any serious degree as a result of these tillage intervals.

Arsenic residue analyses of the soil showed no increase or decrease with regard to days after treatment. The amount of cacodylic acid used in these studies has little effect on increasing the total arsenic content of soils where compared to areas which received none. The arsenic content of Sudangrass foliage is not appreciably increased on plots treated with cacodylic acid. In no instance did the amount present exceed 1 ppm.

Additional studies were conducted under greenhouse conditions to evaluate the speed of penetration of cacodylic acid and the effect of light intensity on the phytotoxicity. Orchardgrass plants were subjected to varying intervals of herbicide contact, after which they were washed to remove the herbicide which presumably had not been absorbed. After three hours of herbicide contact, the fresh weight had been reduced to 20% of the control and after 16 hours it was found that cacodylic acid is absorbed very rapidly.

Oats and bluegrass were subjected to varying light intensities before and after foliage treatment with cacodylic acid. It was observed that when preconditioned at low intensities, treated and returned to high intensities, the degree of injury was the greatest. When preconditioned at high light, treated and returned to low light, the injury was much less. Plants pre- and postconditioned under high or low light were intermediate in injury. It is believed that the effect of light may be related to the cuticle. Under low light less lipoidal material is deposited and thus the absorption is enhanced.

Title: MILK PRODUCTION OF DAIRY COWS FED NITROGEN-FERTILIZED
ORCHARDGRASS COMPARED TO ALFALFA

Leader: C. H. Ramage

Two lactations of a three-lactation study have been completed. Results indicate that cows on alfalfa will eat more and produce more milk than cows on nitrogen-fertilized orchardgrass, even though the crude protein contents of the forages are similar. The following table summarizes the two-lactation results.

Average 245-day FCM yield and DM intake for two lactations.

Feed	Pounds of concentrate in 245 days	245-day FCM yield	245-day forage DM intake	% Protein in forage
Forages				
N-fertilized orchard- grass		7379	5936	16.40
Alfalfa		8395*	7153**	16.70
Grain Levels				
No grain	0	6372	7658	
Low grain	1155	7413	6694	
Medium grain	2310	8353	5833	
High grain	3465	9411	5996	

* Significant at 5% level

** Significant at 1% level

Title: EVALUATION OF KENTUCKY BLUEGRASSES FOR GRAZING

Leaders: M. A. Sprague, J. G. Welch and B. Brooks Taylor

Merion and Common Kentucky bluegrasses were sown in pure stand in large plots in a pasture to be grazed by sheep. Plots of natural species, consisting primarily of bentgrasses, bluegrasses, and broadleaf weeds, were retained for comparison. Establishment was accomplished in September 1961 on seedbeds previously treated with dalapon and cacodylic acid to rid the area of all established species. Four levels of complete fertility will be established in large plots during spring 1962 and rotational grazing with sheep undertaken during this and subsequent seasons to determine relative performance of the three pasture mixtures.

Title: SILAGE INVESTIGATIONS

Leaders: M. A. Sprague and B. Brooks Taylor

An experimental silo technique was devised to ensile freshly harvested forage directly as it is blown from the field chopper. A light sheet metal cylindrical form, 6 ft. in diameter and 5 ft. high and separable into two sections by means of pinned hinges, was placed on a two wheeled dump trailer and drawn behind the field chopper. A polyvinyl chloride plastic bag was fitted over the bottom end of the cylinder and the whole assembly placed on a thin sheet of building board which in turn rested on the trailer. As the fresh cut forage was blown into the form, samples were taken for analyses and thermocouples and pH electrodes put into place in the settling forage mass. When completely filled, the trailer was detached from the chopper and pulled to the desired location. Unloading the silo consisted of tipping the dump trailer, fitting a rope sling around the cylinder, and sliding the entire unit to the ground surface as the trailer was moved forward. The cylindrical form was then unhinged and removed; the plastic film drawn up into place and tied tightly; and the form returned to the trailer for the next unit. Each silo holds approximately two tons which permits easy weighing. A total of thirteen were filled in September 1961.

Corn and sorghum crops were grown at two levels of nitrogen fertility and harvested at early and late maturities for silage. Of particular interest was the influence of fertility and maturity on the protein, nitrate, and carbohydrate contents of the green forage. These in turn were to be observed for the influence of observed variables on the percent retention of these and other nutrients in the silage.

Total dry matter losses averaged less than 3%. Temperatures increased up to 10 F during the first 60 hours after filling and were greater in the more mature forages. The pH electrodes with extension leads were placed in some of the forage masses, two of which presented good readings. The pH of the fresh corn forage, at 5.8, dropped to 4.8 in 24 hours and to 4.2 after an additional 16 hours. Lowest pH recorded was 3.6. As this was the first attempt at getting continuous pH readings, techniques can be improved another season. Samples of grasses evolved at intervals following sealing of the bags were drawn and analyzed on a mass spectrograph. Large quantities of carbon dioxide and nitrogen were found as expected. Virtually no oxygen was detected but some argon was observed. More complete chemical analyses of fresh forages and silages are currently underway.

NEW YORK (CORNELL)

Title: BREEDING AND CYTOGENETIC INVESTIGATIONS

Leaders: R. P. Murphy, R. E. Anderson and C. C. Lowe

The program to add wilt resistance to Narragansett and Flemish-type alfalfa is continued (1960 Annual Report, page 94). Intercrosses of selected 3rd backcross plants are being grown for field screening at a wilt-inoculated site.

Plants selected for high seed set from the variety Narragansett have been studied further. Morphological characteristics, particularly vigor ratings, were determined from field nurseries of the following progenies: selfed, open-pollinated and hand-crossed to high and low seed set parents. The results confirm that a significant amount of selfing did occur in the seed production field from which the Wyoming selections were made. Greater vigor was found associated with high seed set clones than for those selected for low seed set. Whether this is a true population characteristic, a result of biased selection or genetic consequence of fertility relationships is not known.

A synthetic of 25 high-seed-set clones is under evaluation and several field trials are in progress for studying variation among increase generations of the variety and variation among restricted polycrosses of high-seed-clones and different breeders seed lots.

The studies on genetics and competition effects for creeping-rooted alfalfa have continued. Comparisons of selfed and crossed progenies show that sod competition definitely affects the degree and time required for expression of the character. Degree and time of expression are also affected by the genetic background of the character. Expression is related to general vigor; any gene or genes affecting vigor indirectly can be said to affect creeping. There is little evidence that the gene or genes for creeping are closely linked with any one plant type even though low seedling vigor and growth rate of most selections have qualities closely resembling the falcata material from which the character was originally obtained. Breeding methods employed have been successfully directed to obtain a very high gene frequency for creeping rather than for introducing it into a genetic background conducive to high vigor.

Genetic studies are also in progress on the genetics and association of white flower color and white seed-coat color. An interesting discovery, once previously reported in the literature, was the occurrence of a white-flowered chimaera on the terminal end of a raceme from a purple-flowered plant. Several flowers were selfed and outcrossed to other plants.

Single-cross and selfed progenies of selected orchardgrass clones are being studied as spaced plants and single-crosses also in broadcast plots. Similar studies on timothy are being continued and will form the basis for selection of parental material used in methodology studies in strain synthesis which will be conducted under regional Project NE-28.

Title: BREEDING AND EVALUATION OF IMPROVED VARIETIES OF FORAGE CROPS
ADAPTED TO NEW YORK AND ADJACENT AREAS OF THE NORTHEAST

Leaders: C. C. Lowe, R. E. Anderson, R. P. Murphy and A. A. Johnson

After finding management x strain interaction in the polycross testing of brome grass, testing procedures have been revised to allow selection under critical conditions for brome grass survival. Improvement in survival under conditions of severe harvest management with companion plant competition appears to be a primary need for this species. Fifty-two clones originating from second-cycle selection are now being progeny tested by this procedure. Seed has been drilled in 50-ft. rows with a Planet Jr. seeder followed by overall seeding of the replicated test with vigorous alfalfa. Management of four harvests per season with a 5-week cutting interval which has been critical for survival of brome in past tests will be applied. These clones have been progeny tested previously for yield at New York and are also in yield tests currently under regional Project NE-28.

Three years of progeny testing for 112 second-cycle orchardgrass clones and 85 second-cycle timothy clones were concluded in 1961. The most promising of these are now being used for production of synthetics and in advanced polycross progeny tests. In orchardgrass, a diversity of desirable vegetative traits is present but the second-cycle appears to have made little progress toward improved seed production characteristics in association with late maturity. In timothy, good progress appears probable for obtaining better agronomic properties in association with the highly desirable lateness in maturity. For both of these species, dry matter content at harvest, appears to be a very reliable progeny maturity indicator.

Cooperative testing with the U.S.D.A. is still in progress for performance of alfalfa single crosses and for variety crosses and blends. Single-cross performance for some clones is outstanding; this information will be utilized in future synthesis of new experimental lines. Tests are also in progress for determining genetic shift in Ranger and Atlantic alfalfa from various increase procedures and locations in the West during the past decade. Also in conjunction with the U.S.D.A., components of Essex timothy and Saratoga brome grass from synthesis of these strains under diverse Western environments are being studied for resultant change in performance under seed production environment.

Regional evaluation has begun on synthetics and hybrids of alfalfa produced under contract in California for the purpose of studying methods of variety synthesis in this species. Similar procedures are planned for corollary studies in several grass species.

Title: BREEDING AND STRAIN EVALUATION ON FORAGE SPECIES IN NEW YORK FOR IMPROVED FEEDING VALUE, YIELD AND SEASONAL DISTRIBUTION OF FORAGE

Leaders: C. C. Lowe, R. E. Anderson, R. P. Murphy, A. A. Johnson and J. T. Reid (Animal Husbandry) and M. J. Wright and H. A. MacDonald (Agronomy) Cooperating

Alfalfa (1960 Annual Report, page 97)

The 1961 growing season in upper New York was one of the most favorable on record for forage production. Cool June weather with an unusually warm and late fall gave near-ideal conditions. Average yields on some second-year alfalfa trials exceeded 7 tons/acre under 3-cut management.

First-year harvest data were obtained from an extensive series of trials (some under NE-28) comparing Cayuga and 4 other experimental N.Y. strains at a number of sites. Unfortunately, first-year performance for Cayuga in some of these trials (and in demonstrations in several states) has been adversely affected by low seed quality of the seed lot distributed. Seed laboratory analysis discerned unusually high mechanical injury with rapidly falling germination. Adverse effects were confirmed in comparative tests with other seed lots at Ithaca.

Very good production continuing into the fourth harvest year was obtained on Cayuga in older trials under intensive management in comparison to Flemish-type strains. Continued good production is obtained on Cayuga under these conditions 1-2 years longer than for the Flemish-types. Bacterial wilt resistance is one factor involved but not the only one since Narragansett is often observed to persist somewhat longer than DuPuits and other similar varieties.

Current trials include experimental strains derived after several generations of backcrossing Narragansett and DuPuits to wilt-resistant stocks. These should help in understanding the relative importance of several persistence factors.

Orchardgrass

Residual effects of previous management and association for 11 varieties and synthetics were determined by fourth-year production under uniform management. These essentially confirmed the observations made (1960 Annual Report, page 98) on this extensive evaluation of improved orchardgrasses of different maturities during the previous three-year period.

The strain designated as Pa. Med. Syn. II was both visually and statistically superior in the advanced harvest years of production. This appeared to be connected with some persistence qualities rather than a chance combination of favored management.

Early, late and medium maturity strains were compared from harvests made on several dates for first growth and aftermath harvests in digestibility and feed intake trials with sheep. Early results tend to indicate that feeding value of late orchardgrass relative to early strains may be somewhat less than expected from similar comparisons on timothy. Within and between species trials of this nature are continuing to help appraise the complete relative merit for new varieties of orchardgrass.

In conjunction with animal trials for feeding value of forages, studies have been continued on the investigation of dry matter content at time of harvest as a criterion of feeding value. Early results indicate that this is measurable with a low degree of error and the correlation with feeding value may equal or be superior to various proposed chemical constituent analyses.

A comparison of interest is found in data from a current regional trial series at a high elevation location in the hill country of the state. Mixtures of DuPuits, Narragansett and Vernal alfalfas with each of 3 grasses were established on the same site for three consecutive years. Yields have now been obtained for four harvest seasons. A unique opportunity is thus provided to separate the effects of seasonal variation and stand age for varieties and mixtures under a representative environment and management. Data collected to date (averaging all mixtures) show that under the existing conditions, production potential declined steadily from the first through the fourth year in the following manner for alfalfa-grass hay:

1st hay year	.13 T/A	>	2nd hay year	.16 T/A	>	3rd hay year	.30 T/A	>	4th hay year
--------------	---------	---	--------------	---------	---	--------------	---------	---	--------------

Average yields for the first test planted in 1957 were: 1958-4.17 T/A; 1959-2.75 T/A; 1960-3.93 T/A; 1961-4.52 T/A.

Without comparative trials of different age, obviously no accurate estimate of changes in production potential is possible. At present, the average difference between any two seasons is .92 T/A (includes stand age and season); when adjusted for age, it is 1.13 T/A. At this yield level, it would be necessary to plan for at least 25% in excess of expected normal production capacity to provide adequate forage in unfavorable seasons.

Title: FORAGE DISEASES

Leaders: L. Lopez-Matos and R. L. Millar

In 1958, Southern Anthracnose developed in epiphytotic proportions in alfalfa fields located near New Berlin, New York. A survey of fields of forage legumes in 21 counties of the state in 1960 revealed that the causal fungus (Colletotrichum trifolii Bain) was established in a few fields in only 2 counties.

An investigation was undertaken to determine if the causal fungus was a strain of C. trifolii adapted for development at lower temperatures than those that prevail in the South where the disease has been prevalent for many years. The results of experiments on the effect of temperature on growth, spore germination, infection and symptom development for the New York isolate were essentially the same as those reported for C. trifolii in the South. The fungus is capable of overwintering under New York conditions both in living and in dead tissues of alfalfa and clover but its survival rate is low.

As a result of the survey, 48 isolates of Colletotrichum were obtained, all of which were pathogenic on young seedlings of DuPuits alfalfa. Variation of morphological characters of the isolates, especially spore size and shape, made it difficult to place them in recognized species and to reconcile them with descriptions in the literature. Consequently, four groups were established on the basis of spore size and shape and these were assigned to three species: 1) C. trifolii Bain in Bain and Essary descr. emend. Lopez -- (Isolates with short, broad spores which are cylindrical and rounded at both ends to ovoid, 11-15 x 4.8-7.0 microns with a width/length ratio of approximately 0.4); 2) C. destructivum O'Gara -- (Isolates with spores which are straight or slightly curved, rounded at both ends, blunt at both ends, or rounded at one end and blunt at the other, with a spore width from 3.18-4.78 microns and width/length ratio of 0.22-0.29); and 3) C. dematium (Pers. ex Fr.) Grove forma truncata (Schw.) v. Arx. -- (Isolates with spores that are sickle-shaped with a width/length ratio of 0.15).

C. destructivum was found to be widely distributed in the State; it was isolated from alfalfa, red clover, Ladino clover, burr clover and birdsfoot trefoil. C. dematium f. truncata was isolated from one field each of clover and alfalfa and from alfalfa in experimental plots at Cornell University.

Representative isolates of C. trifolii and C. destructivum were tested for virulence on seedlings and grown plants of several varieties of each of alfalfa, red clover and birdsfoot trefoil. Isolates of C. dematium f. truncata were tested only on seedlings of DuPuits alfalfa. Both C. trifolii and C. destructivum were more virulent on seedlings than on grown plants. C. trifolii was more virulent than C. destructivum on all varieties of alfalfa, red clover and birdsfoot trefoil.

Birdsfoot trefoil varieties were resistant to both C. destructivum and C. trifolii. Red clover varieties were moderately resistant to C. destructivum and susceptible to C. trifolii. Alfalfa varieties were susceptible to C. destructivum and highly susceptible to C. trifolii.

Both C. trifolii and C. destructivum developed abundantly on the stubble of clipped plants. This was considered to be significant for two reasons: 1) the cut stems served as an avenue by which the fungi invaded the crown; 2) the inoculum produced on the cut stems apparently was responsible for the death of many of the young shoots that were produced subsequent to clipping.

Title: INFLUENCE OF DATE OF CUTTING, NITROGEN FERTILIZATION AND IRRIGATION UPON THE YIELD AND DIGESTIBILITY AND INTAKE OF DIFFERENT FORAGES BY RUMINANTS

Leaders: M. J. Wright, W. G. Monson (ARS, USDA), K. L. Davison, and R. F. Burt

Grazing studies were initiated on 10 pasture mixtures consisting of common and Essex timothy, Lincoln and Saratoga brome grass, and common orchardgrass, each with Narragansett and DuPuits alfalfa. Twenty-four Holstein steers were used in the study in 1961. Chromic oxide was fed to the animals individually in one pound of ground corn daily at the rate of 20 g. per animal per day. The cattle were obtained too late to get any valid data on the initial growth of the pastures. Intake and digestibility data were obtained on most of the mixtures on the aftermath. Grab samples were collected from the animals during a 4-day period on each mixture.

The estimates of fecal output and consequently of intake appear to be quite high in most instances. The estimated digestibilities are quite uniform and indicate only small differences in digestibility of the aftermath growth. Twenty-four steers appear to be too many to handle effectively in this type of study. In 1962 the number will be reduced to 16 and the number and frequency of grab samples will be increased during all test periods. Plant counts are being taken twice yearly in all plots using permanent quadrats. All plots are rated visually just prior to each grazing cycle. These ratings in 1961 showed DuPuits to have a greater recovery potential than Narragansett in all mixtures, but the grasses usually received higher ratings when associated with Narragansett than with DuPuits.

Twenty Holstein heifers are being subjected to various periods and levels of dietary nitrate during their first pregnancy. Observations of their physiological and reproductive responses are being accumulated prior to calving, after which both cows and calves will be slaughtered and subjected to thorough histopathological examination. Twenty more heifers will be placed on the same rations in May. Four fistulated heifers and a colony of guinea pigs are being used for additional studies on the effects of nitrate.

Corn plants are being grown in nutrient solutions in control chambers to test the influence of various environmental factors on nitrate accumulation. Studies on nitrate reductase are being made with oats.

Title: MANAGEMENT AND PRODUCTIVITY OF PERENNIAL GRASSES

Leaders: M. J. Wright, W. G. Monson (ARS, USDA), and J. E. Begg

Detailed studies of the development of vegetative shoots of Phalaris arundinacea have demonstrated that the blade and other parts of the phytomer have completed their elongation by the time they emerge into view at the apex of the shoot. Such blades did not resume growth when severed at various distances from the tip, indicating that the isolated meristem described by some workers is not present in this species.

Systematic defoliation of leafy shoots was employed to study the influence of loss of photosynthetic surface on rate of appearance of new leaves, size of new leaves, elongation of internodes, and accumulation of root reserves. A remarkably consistent pattern of behavior was exhibited. The production of new leafage had the highest priority in utilization of available photosynthetic capacity, and the rate of leaf appearance was not appreciably altered so long as shoots maintained one expanded leaf. Elongation of internodes had second priority, and replenishment of reserves, third.

Title: BIRDSFOOT TREFOIL INSECT INVESTIGATIONS

Leaders: S. W. Jacklin and George G. Gyrisco

Some of the most important insects of the seed of birdsfoot trefoil are plantbugs. Of the five species of plantbugs, the tarnished plantbug is the most common. Work on its biology, ecology, economic importance and control was continued in 1960.

Studies of the preovipositional period indicated that lower temperatures have a greater effect than length of day in prolonging the preovipositional period. It was also found by use of a wind tunnel that plantbugs can fly into winds at least up to 2 m.p.h. and that nymphs are more destructive than adults to birdsfoot trefoil causing the florets to blight, buds to blast and young seed to shrivel.

Screening of insecticides indicated that Trithion, Dylox, Dibrom, Shell SD4402 and Dimethoate were the most effective for plantbug control on birdsfoot trefoil. An entomophagous fungus, found attacking the tarnished plantbug was not highly infectious.

Work on the biology, ecology, and control of the tarnished plantbug continued in 1961.

Studies of the preoviposition period indicated that with 2-day lengths (16 hr. and 8 hr.) the average preoviposition period is about 9.5, 11.0, 16.0, and 17.8 days at temperatures ranging from 30 to 15 C in 5° steps. Under the 8-hour day and 15 C temperature no eggs were laid. At 35 C results were poor indicating that this temperature is excessive. Lower temperatures had a greater effect than length of day in prolonging the preoviposition period.

From the wind tunnel study started last year, it was concluded that plant-bugs cannot fly into winds greater than 4.0 m.p.h.

A study of insect mobility showed that insects may move from a check plot area into a sprayed area with the result that the check plot population is underestimated.

A quick pre-field-use laboratory insecticide screening scheme for estimating field application rates was designed and used quite successfully.

Title: FORAGE INSECT INVESTIGATIONS

Leaders: H. Y. Forsythe, Jr. and George G. Gyrisco

White grubs: Brood C of Phyllophaga as grubs was the heaviest in years after a year of rather heavy damage, the greatest since 1942. A heavy flight is anticipated in May and June of 1961 in the Champlain Valley, western New York (Erie County) and the southern tier this year.

Pea aphid: For pea aphid in 1960, the best controls after 7 days were obtained with Dimethoate, Phosphamidon, Trithion, Guthion, Methyl trithion, Phosdrin, parathion, endrin, lindane, malathion, Malathion SF-60, and EPN. After 14 days, Dimethoate, Phosphamidon and endrin were best, and these all gave effective control over the 2-week period.

Grasshoppers: The best insecticides for grasshopper control in 1960 were found to be endrin, lindane, heptachlor, parathion, Trithion and Dimethoate when evaluated 14 days after treatment.

Meadow spittlebug: For meadow spittlebug adults, endrin, lindane, Phosdrin, Guthion, methoxychlor, Dibrom and Methyl trithion all showed excellent control after two days but none persisted long.

Statistical Studies of Insect Control Data: In a study of transformation for statistical treatment, either the square root or log transformation scale seemed to be appropriate for the majority of the pea aphid randomized complete block experiments. For grasshoppers, neither seemed to eliminate the notations of the assumptions necessary for the analysis of variance procedure and its related tests of significance. For spittlebug adult data, both square root and log scale transformations can be used with confidence.

Title: FORAGE INSECT INVESTIGATIONS (1961)

Leaders: H. Y. Forsythe, Jr. and George G. Gyrisco

Clover root curculio: Heptachlor and methyl parathion granules gave good control of the clover root curculio adult 35 days after treatment. Feeding injury to alfalfa roots by the larvae was most effectively reduced by lindane and heptachlor.

Less feeding by the larvae was found in alfalfa fields with 3 to 10% slopes than there was in fields with 0 to 3% slopes.

Pea aphid: The best insecticides for the control of the pea aphid were Vapona, ethion, Phosdrin, and Guthion when evaluated 7 days after treatment. Guthion and ethion continued to show effective control up to 14 days.

Meadow spittlebug: Only Guthion and Phosdrin showed excellent control of the meadow spittlebug adult in 1961.

Distribution patterns of certain insects: The meadow spittlebug nymphs were found to be distributed in a non-random manner among the plants in an alfalfa field. The distribution was characterized by a tendency of the nymphs to form aggregations.

The pea aphid also showed a tendency to form clusters on the plants in alfalfa fields in the spring and late summer. The numbers of aphids were very low during the main part of the 1961 summer season.

Title: INSECTICIDE RESIDUES IN MILK AND EGGS

Leaders: D. D. Hardee and George G. Gyrisco

During the past year, a study of the metabolic fate of Sevin fed to dairy cows was concluded. It showed that milk from orally dosed cows (450 ppm) is free of the residues of Sevin, 1-naphthol (the hydrolysis product), and detoxified conjugates of 1-naphthol. Part of the Sevin appeared in urine as conjugates of 1-naphthol or Sevin or both. Another part was found unchanged in the feces as Sevin.

Duplicate pens of White Plymouth Rock chicks were fed 0, 5, 10, 20 or 100 ppm of malathion. Records were kept of food intake and weight gains. The chicks were fed for two weeks and slaughtered when bronchitis appeared in the flock. Each pen was pooled for analysis for malathion. Malathion had no effect on food intake or growth of the chicks; no residue was found in the meat.

Title: INSECTICIDE RESIDUES ON FORAGE CROPS

Leaders: D. D. Hardee and George G. Gyrisco

Analysis of samples of alfalfa to which lindane (EC) was applied at 2 oz./A (act. tox.) and sampled 44 days later showed an average lindane residue of 1.0 ppm.

Alfalfa was sprayed with EPN at 0.25 and 1.50 lbs./A and sampled after 18 and 15 days, respectively. Analysis for EPN revealed an average residue of 0.024 ppm for the 0.25 lb. rate and 1.19 ppm for the 1.5 lb. rate.

Application of heptachlor and methyl parathion granules to red clover at the rate of 1.0 lb./A in the fall of 1960 resulted in residues of 0.12 ppm heptachlor and 0.013 ppm methyl parathion the following spring.

Analysis of alfalfa samples taken at intervals of 7, 19 and 41 days after treatment with heptachlor (EC) at 2 and 4 oz./A failed to disclose any heptachlor residue. Endrin, though not applied, was detected in appreciable amounts in these samples.

Granular dieldrin applied in the fall at 5.0 lbs./A for the control of the alfalfa snout beetle, Brachyrhinus ligustici (L.), did not produce any detectable residue in fields of alfalfa sampled the following spring.

In the summers of 1960 and 1961, samples for residue analysis were taken at intervals up to 28 days following treatment of different forage crops with emulsifiable concentrates of various insecticides. Results were somewhat variable but in general indicated that the initial deposits and persistence of the insecticides on the forage crops were as follows: Alfalfa, birdsfoot trefoil, and red clover.

Residues of Diazinon averaged 31.96, 2.03 and 0.53 ppm at 0, 7 and 14 days, respectively, following application of 1.0 lb./A of emulsifiable Diazinon to alfalfa.

Title: THE ADAPTATION OF ALFALFA AND BIRDSFOOT TREFOIL TO VARIATIONS IN SOIL MOISTURE CONDITIONS AND AERATION OF THE ROOT MEDIUM

Leaders: D. W. Evans, E. R. Lemon and H. A. MacDonald

Studies were set up to (a) evaluate possible differences between forage legume species and varieties in relation to their success or failure when seeded on soil of different moisture states, (b) evaluate the response of alfalfa and birdsfoot trefoil to differences in oxygen (O₂) and carbon dioxide (CO₂) supply in the root medium, and (c) assemble information which will provide a basis for more valid decisions regarding species and variety seedings suited to specific soil conditions.

Initial studies were made of seedlings of a number of different alfalfa and birdsfoot trefoil varieties under conditions of known soil moisture variability. These established seedlings included the alfalfa varieties DuPuits, Narragansett, Ranger and Vernal, and the birdsfoot trefoil varieties Empire and Viking. It was found that while the alfalfa varieties differed in growth habit, seedling vigor, growth rate and forage yield, they did not show the "expected" differential adaptation to changes in soil moisture conditions. All alfalfa varieties changed in adaptation, as measured by vigor and persistence, at about the same "break" in soil drainage condition. None persisted under conditions of poor drainage. Empire and Viking birdsfoot trefoil did not present differences between themselves but both persisted and produced well on soil too poorly drained for the alfalfa varieties studied. They did fail on flooded areas, however.

To investigate the problem further, laboratory studies were initiated. Seedlings of alfalfa and birdsfoot trefoil varieties were grown in nutrient cultures through which air of differing O_2 and CO_2 concentrations was bubbled, thus producing differing partial pressures of these gases in the solutions. The development of the root was used as one of the criteria of the tolerance of the legumes to the stresses applied.

In the case of alfalfa, a reduction in O_2 to 5% or lower, resulted in a marked reduction of root length, root number and degree of branching. This was most severe at high CO_2 levels. All alfalfa varieties used in these experiments behaved similarly in this respect and were not significantly different from one another.

The effect of differing aeration on birdsfoot trefoil was in the same general direction as that of alfalfa but was much less marked. Birdsfoot trefoil showed greater tolerance to low O_2 and high CO_2 in the medium than alfalfa, but the varieties again did not differ in this regard.

Conclusions: While this work is incomplete, the studies indicate a great and consistent difference between alfalfa and birdsfoot trefoil in adaptation to situations of poor aeration. Birdsfoot trefoil may be expected to be better suited to soils of poor drainage and thus poor aeration, than alfalfa. Marked differences between common varieties of these crops are not indicated, however.

Title: MAXIMUM UTILIZATION OF FORAGES BY LIVESTOCK

Leaders: S. T. Slack, K. L. Turk, G. W. Trimberger, J. I. Miller,
 J. T. Reid, D. E. Hogue, W. G. Merrill, and J. K. Loosli,
 (Department of Animal Husbandry) and M. J. Wright, W. K.
 Kennedy and H. A. MacDonald, (Department of Agronomy).

An experiment to measure differences in forage appetite and compare heat-dried with barn-dried hay, together with different frequencies of feeding during the entire lactation of high-producing Holstein cows is in progress for the second year and will be continued for one more year.

The results from an experiment comparing the digestibility and feeding value of birdsfoot trefoil and a legume-grass mixture harvested for hay by different methods have been summarized for publication in bulletin form. There was no appreciable difference in production between the first-cutting and second-cutting hay for either the Viking birdsfoot trefoil or legume-grass hay. Cows on the early-harvested and second-cutting birdsfoot trefoil consumed an average of 38.3 pounds of hay containing 33.2 pounds of dry matter per day, compared to 38.6 and 33.6 pounds, respectively, for the legume-grass control group. Cows on the late-harvested, first-cutting, field-cured Viking birdsfoot trefoil consumed an average of only 28.8 pounds of hay containing 25.2 pounds of dry matter. This indicates that a postponement in cutting date of birdsfoot trefoil affects palatability and daily consumption to about the same extent as in other legume and mixed forages studied previously.

Studies were made of the differences in the productive values of early- and late-cut hays for growing heifers and growing fattening lambs. The main objective of this experiment was to determine the difference in productive value of hays cut at different dates for heifers and lambs and to determine the amounts of energy and protein to be added to rations of late-cut hay to equal the performance of early-cut hay. Three lamb trials were carried out during the winters of 1958-59, 1959-60 and 1960-61. A preliminary trial with heifers was carried out in 1959-60. Two similar trials with heifers were run during the winters of 1960-61 and 1961-62; the latter trial is still in progress. When the trials are completed and the data are tabulated, the results will be summarized in bulletin form.

Three experiments were conducted to determine the value of hay pellets as a replacement for ground corn and/or good improved permanent pasture for fattening yearling steers. Mixed hay pellets (11 to 15% protein) were worth up to 75% as much as ground corn. However, results indicated that hay pellets probably have their greatest value for fattening steers on pasture when the pellets are of high quality relative to the pasture grass and when limited amounts are fed.

Title: A STUDY OF THE SOURCES AND CONTROL OF NUTRITIONAL LOSSES
OCCURRING DURING THE HARVESTING AND STORAGE OF HAY AND
SILAGE

Leaders: M. J. Wright and S. W. Day

The influence of partial drying before storage on the course and rate of fermentation of silage was investigated through the use of partition chromatography. When pure chopped alfalfa was dried from its initial 80% moisture content to 75, 70, 65, 60, 55, or 50%, there was a general and progressive suppression of fermentation as measured by percentage conversion of dry matter to organic acids. Lactic, acetic, and formic acids predominated, and were generally present in that order of abundance; nearly all the samples were acceptable or better, the main exception being those reconstituted with water to 80% moisture after initial drying to 70%. In nearly all samples pH was above 4.6.

PENNSYLVANIA

Title: THE GENETICS AND IMPROVEMENT OF PERENNIAL FORAGE LEGUMES

Leaders: R. W. Cleveland and J. L. Starling

Alfalfa: The breeding of creeping-rooted alfalfas was continued. Progenies of crosses between creeping-rooted clones and hay-type selections from adapted varieties were established in source nurseries in preparation for evaluations and selection of plants with creeping habit, and other desirable economic traits. Crosses were made between selected creeping-rooted clones and plants of Vernal, Narragansett, DuPuits, and Moapa. The experiment was designed as an 8 X 8 balanced lattice with 4-plant plots and the plants spaced on three-foot centers. In addition, the extra F_1 's were established in a separate planting, making a total of approximately 10,000 plants. Evaluations will be made for the first time in 1962.

An experiment designed to evaluate the performance of alfalfa variety blends (mixtures of seed of two varieties), with several blend proportions and several seeding rates as variables, was continued. The second year's data were obtained in 1961 and the results were found to be at considerable variance with the data of 1960. One more year's data will be gathered before conclusions are made. The results of this experiment may expose a number of desirable or undesirable traits of variety blends.

Genetic studies in alfalfa consisting of inheritance of ovule number, pollen-tube growth and several other characteristics of leaf and flower were continued. Results of the first two studies are available in thesis form (D. K. Barnes, Penna. State Univ. 1962).

Red Clover: Breeding for resistance to Northern Anthracnose was continued. BC₁ plants were grown and intercrossed. Plants grown from intercross seeds were inoculated with Kabatella caulivora and approximately 23 were found free of lesions characteristic of Northern Anthracnose. These plants will be used as the non-recurrent parent in the BC₂ to Pennscott. Studies of the inheritance of resistance to this disease were also continued. F₂ and backcross progenies from F₁'s of resistant X susceptible crosses were inoculated and scored in the greenhouse and in the field. This study was not conclusive but will provide a background for further investigation.

Experiments for testing red clover, alfalfa, and birdsfoot trefoil varieties were continued at several locations in Pennsylvania. Introduced strains of several legume species are also being observed for traits useful in breeding. Several new varieties appear to be adapted for use in this state and those with adequate testing background have been recommended for farm use.

Cytological Studies in Medicago: A study of root-tip mitoses showing aberrant chromosome behavior in a strain of alfalfa was initiated. Abnormal occurrences such as mitotic bridges, variability of chromosome number, and fragmented chromosomes have been observed.

Title: CYTOGENETICS OF FORAGE CROP SPECIES AND INTERSPECIFIC HYBRIDS

Leaders: J. L. Starling and R. W. Cleveland

Species Hybridization in Trifolium: Diploid and amphiploid T. pratense X T. diffusum hybrids were studied. Quantitative measurements of several morphological characteristics were made for comparison to the parents, and progeny pollen mother cells and root tips were collected and cytological analyses made. The hybrids were backcrossed to T. pratense and an F₂ was also produced on the amphiploids.

Further attempts at hybridization resulted in one sesquidiploid plant from the cross T. pratense (4X) X T. diffusum (2X). The crosses T. pratense (4X) X T. pallidum (2X) and T. pratense (4X) X T. hirtum (2X) each resulted in one probable hybrid plant. Cytological and fertility studies are planned for these hybrids. All Trifolium studies represent Ph.D. thesis research being carried out by Mr. Joseph Schwer. Many of these hybrids may be useful in clover breeding.

Species Hybrids in Phalaris: A study by Mr. T. Devine to determine the causes of differential crossability of P. arundinacea and P. tuberosa was continued. Material has been collected for an embryo-sac development study, and microscope slide preparations have been made.

Title: MAINTENANCE FERTILIZATION OF GRASSLANDS IN PENNSYLVANIA

Leader: L. F. Marriott

NPK topdressings on common orchardgrass were continued in the sixth year on Berks shaly silt loam and in the fifth year on Bucks silt loam. Application of 200 pounds of N and adequate PK annually resulted in 1961 yields as high or higher than in any former year of the experiment. These yields were 3 T/A on Berks soil and 3.5 T/A on Bucks soil. Check (no N) yields averaged 1.25 T/A. Leaving K out of the fertilizer program resulted in a reduction of about a ton of dry matter when 200 pounds of N were used. P was not an important limiting factor.

Soil test results for P and K were clearly correlated with fertilizer applications.

Late summer applications of 100 pounds of N (+PK) or 800 pounds of 10-10-10 were 80 to 85% as effective as spring applications of the same kind and rate of materials.

Title: THE GENETICS AND IMPROVEMENT OF FORAGE GRASSES

Leaders: J. L. Starling and R. W. Cleveland

Orchardgrass Breeding: A spaced planted nursery of 1900 plants was established for critical clonal evaluation and for the production of polycross seed. Parental clones were selected from a source nursery on the basis of vigor and apparent resistance to diseases. Evaluation was completed for restricted polycross progenies of three selected groups of clones. The experimental synthetic, Pa. Medium II, was the best experimental in these trials. Breeders seed was produced for Pennlate and the breeders seed nursery was reestablished. Additional nurseries for experimental synthetics were maintained. Data were collected for the second year from a trial comparing the relative performance of various mixtures of seed from the parent clones of Pennlate, various generations of seed and two locales of seed production.

Bromegrass Breeding: Syn-I seed was harvested from two experimental synthetics for the production of advanced generations.

Phalaris: A trial of reed canarygrass varieties and clones derived from the cross Phalaris arundinacea X P. tuberosa was established for comparing the persistence, yield and morphological characteristics of the hybrid material to reed canarygrass. A crossing block of selected hybrid clones was established. Nurseries for further selection of desirable types of hybrid derivatives were established.

Introductions: Nurseries of introductions established in 1959 and 1960 were evaluated. Outstanding introductions of 1960 were obtained and planted in row nurseries.

Variety Trials: Trials of the newer varieties of orchardgrass and brome-grass were continued at several locations.

Title: PRODUCTIVITY OF FERTILIZED GRASSES

Leader: L. F. Marriott

Using S-37 orchardgrass on Hagerstown silt loam, applications of N up to 200 pounds per acre generally increased yields of dry matter 20 pounds per pound of N applied. Manure applied at 10 or 20 tons per acre resulted in slight but non-significant increases in yield.

Nitrogen applied at 100 pounds per acre in mid October, November, or February was equal in effectiveness to a split application of the same rate, with applications made in the spring and after the first harvest. N applied on 9/15 resulted in a yield of 2.4 T/A, as compared with 3.0 T/A when the N was applied later.

Timothy yields were generally half a ton more per acre than those of S-37 orchardgrass, at equivalent rates of N.

Title: ESTABLISHMENT AND MAINTENANCE OF BIRDSFOOT TREFOIL

Leaders: J. B. Washko and W. L. McClellan

During 1961 investigations were initiated or continued on the following phases of birdsfoot trefoil management: (1) spring vs. mid-summer establishment, (2) fertility as it affects establishment and productivity, and (3) cutting schedule as it influences productivity and survival.

A. Establishment

Spring Experiment: In May 1961, plots of Viking and Empire birdsfoot trefoil were seeded with all combinations of the following fertilizer elements; nitrogen at 0, 45 and 90 pounds per acre, P_2O_5 at 0, 60, and 120 pounds per acre, and N_2O at 0, 60, and 120 pounds per acre. One hundred sixty-two plots were seeded and a preliminary evaluation the following November indicated that stands ranged from 5 to 15 plants per square foot. In the spring of 1962 counts will be made to determine the number of plants which will contribute to 1962 yields.

Mid-summer Experiment: Viking and Empire plots were seeded with 0, 20, 40, and 60 pounds of nitrogen. One series was seeded in mid-July, and another in mid-August. At least five well-developed seedlings were established in all plots by mid-November. These plots will be evaluated in the spring of 1962 to determine winter survival under the various treatments.

B. Fertility

In addition to the above-mentioned experiments involving fertility and establishment, another experiment was initiated at the Bald Eagle Area High School farm to compare the effects of a split vs. a single application of 400 pounds of 0-20-20 fertilizer on a 3-year-old stand. These plots were laid out in a field of Mansfield birdsfoot trefoil that had not been fertilized since establishment. Since the plots were not fertilized until after the first harvest, the differences in yields between methods of application were minor. Because the remainder of the field was not cut on the same schedule as the plots, no check yields could be taken to determine the yield increases owing to fertilization. The one striking effect was the more rapid regrowth of the fertilized area.

In Crawford County, Pennsylvania, boron was applied on a 5-year-old stand of Viking birdsfoot trefoil and Climax timothy that had received annual maintenance applications of 400 pounds of 0-30-30 without boron. Boron was applied at acre rates of 0, 20, 40, and 60 pounds of borax per acre after the first harvest. Only two cuttings were made, and no significant yield differences were noted in the second cutting as a result of the boron applications.

C. Cutting Schedule

In the fall of 1960, late fall cutting treatments were imposed on plots of Viking and Empire birdsfoot trefoil which had been harvested two times previously during the season. Separate plots of each variety were harvested at 6-8 day intervals for 6 weeks and check plots were left unharvested. On May 18, 1961 the first harvest was made from plots that had been harvested October 7, October 13 and October 21 in 1960. The plots that had been harvested the third time on September 16, September 23, and September 30 as well as the check plots were harvested for the first time June 7, 1961. The 1961 dry matter yields are listed with reference to the date of final clipping the previous fall: September 16, 2.96 tons; September 23, 3.00 tons; September 30, 2.89 tons; October 7, 3.05 tons; October 13, 3.11 tons; October 21, 3.12 tons; and, check 2.71 tons per acre. The check plots were harvested three times, the others were harvested four times. If the comparison between treatments and the check is made on the basis of three cuttings, the forage yields from the late fall clipped plots are approximately equal to the check. These plots were clipped one inch above the soil surface at each harvest.

Stand counts were made after the final harvest in 1960, and again in the same area after the 1961 harvests were completed. In the first year, stand survival did not appear to be influenced by the previous year's fall cutting treatment.

At Centre Hall, both Viking and Empire were harvested three times at cutting heights of two and four inches above the soil to simulate a hay harvesting schedule. Plots under this schedule cut at two inches averaged 2.81 tons of dry matter per acre whereas the yield of the plots cut at four inches averaged 2.21 tons. The yield of Viking was approximately .5 ton higher than Empire.

These same treatments were included at the Bald Eagle High School farm, and the average yields of Mansfield were 2.94 tons for plots cut at two inches and 2.26 tons of dry matter per acre for plots cut at the four-inch height. Comparable results were obtained from the Crawford County experiment.

Regrowth of birdsfoot trefoil appears to originate primarily from the crown. On the plants cut at the four-inch height, less than 10% of the regrowth came from activated axillary buds on the stubble. Grasses in association with birdsfoot trefoil appear to be favored by the higher height of clipping.

Clipping schedules to simulate delayed grazing or "stockpiling" also were included in the Centre Hall Experiment. These plots were harvested 3 times and clipped one inch above the soil surface; harvests were made on five different schedules. Highest yields were realized from harvests made in mid-June; mid-August; and mid-October. The TDN percentage decreased almost 10% by delaying the first harvest from June 7 until June 16.

Title: UTILIZATION OF FORAGE BY BEEF CATTLE

Leaders: J. B. Washko, P. J. Phillips, R. C. Miller, B. R. Kean, A. L. Haskins and J. K. Pasto

One hundred eighty-three Hereford and Angus grade steers, weighing approximately 600 lbs. each, stocked at one acre per animal unit, were grazed on legume-grass and nitrogen fertilized grass swards with periods of grain feeding as variables until they reached approximately 1000 pounds liveweight. Results were as follows: the nitrogen fertilized grass pastures averaged 5.3 tons of dry matter per acre and the legume-grass pastures 4.3 tons during the grazing season. Beef production in pounds per acre for the different feeding systems averaged 278 on pasturage alone, with 5 lbs. of corn and cob meal daily and pasturage 322, on pasturage but grain feeding not started until 60 days after initiation of grazing 303, and on pasturage but grain feeding beginning 90 days after initiation of grazing 310. The potential beef production possible under these four systems of feeding (calculated with excess spring pasturage preserved as silage and converted to beef) would have been 338, 382, 376 and 351 pounds per acre, respectively.

Cattle made similar gains during the first 60 days on pasture irrespective of whether grain was fed or not. Also, when carcass characteristics following slaughter were compared for the cattle on continuous grain and those without grain for the first 60 days only minor differences were noted between the two groups as regards dressing percentage, conformation score and quality score. Cattle not started on grain until after 90 days of grazing rated only slightly better than those on pasturage alone in rate of gain and carcass characteristics.

These results indicate that when cattle have access to high quality pasturage during the spring months supplemental grain feeding with such forage is unnecessary and is not an economical use of the grain fed.

Title: EVALUATION OF SORGHUM, SUDANGRASS AND MILLETS FOR FEED PRODUCTION

Leaders: J. B. Washko and H. L. Haskins

Greenleaf Sudangrass continued to outyield such other varieties as Piper, Oklahoma hybrid, Stoneville selection and Sweet 372, both at Centre Hall and Landisville.

Of the Sudangrass-sorghum hybrids the commercial types, Grazer, S-100 and SX-11 were superior to several Texas selections which looked very promising in 1959; only Selective 36080 approached the commercial types in yield.

The three highest yielding forage sorghum varieties at Centre Hall were RS 301F, RP 30F and Silo King. At Landisville the latter two varieties and Maconia orange produced the most forage. At both Centre Hall and Landisville several of the sorghum varieties outyielded the corn hybrids with which they were compared. Since chemical analyses have not been completed, the nutritive value of the forage produced by corn and sorghums cannot be compared.

When corn was planted for silage at plant populations of 24,000, 30,000, and 100,000, no advantage was gained from planting more than 30,000 plants per acre. At full dent, the 24,000 plants per acre produced 7.47 tons per acre of dry matter, the 50,000 yielded 8.83 tons and the 100,000 plants produced 8.13 tons. In addition considerable difficulty was experienced in harvesting the 100,000 plant population corn because of severe lodging.

One crop of high population corn produced more dry matter per season than two plantings made the same season.

RHODE ISLAND

Title: FORAGE CROP ESTABLISHMENT STUDIES

Leader: R. C. Wakefield

Experiments were continued to study the effects of intra-species and weed competition on the establishment of legumes (1960 Annual Report, page 115). Development of alfalfa and birdsfoot trefoil plants seeded alone varied in top and root growth depending on seeding rate and degree of weed control in the seeding year. Contrary to first-year results alfalfa establishment was equally good with or without weed competition. High seeding rates gave greater plant establishment but yields did not reflect the differences. Weed control was much more important in trefoil establishment and this was further reflected in top growth harvested during the seeding year.

Second-year data from tests established in 1960 confirmed seeding year data that fewer large plants per unit area may produce very satisfactory yields compared to heavy stands. Differences in yield from stands established under different degrees of weed competition were very small.

Title: INSECT AND OTHER ALLIED PESTS OF FORAGE CROPS AND THEIR CONTROL
UNDER RHODE ISLAND CONDITIONS

Leader: T. W. Kerr

During the season, leafhoppers, thrips, aphids and grasshoppers were the most prevalent insects in pure stands of timothy, orchardgrass, brome grass, alfalfa and in an alfalfa-red clover-timothy mixture. The descending order of preference shown by the leafhoppers, which were especially abundant, was brome grass, timothy, orchardgrass, the grass-legume mixture and alfalfa. The leafhopper species Endria inimica, Draeculacephala antica, Graminella nigrifrons, and Agallia constricta were most abundant on the legumes. One application of 2.25 pounds per acre of sevin applied to the second crop of all stands controlled all species of leafhoppers, except M. fascifrons, for seven weeks. Grasshoppers were controlled for 4 weeks by the treatment, while the populations of aphids and thrips declined initially for 14 to 21 days and increased slightly thereafter.

Title: NITROGEN FERTILIZERS FOR GRASS AND GRASS-LEGUME FORAGE
MIXTURES

Leaders: R. C. Wakefield, J. W. Cobble and J. B. Smith

Grazing trials to compare orchardgrass-Ladino clover with orchardgrass plus nitrogen fertilizer were continued for a third year (1960 Annual Report, page 117).

Results during the three-year period of the experiment show a decreasing advantage of the legume-grass mixture as Ladino clover gradually degenerated from an excellent stand to a relatively weak and minor proportion of the mixture. Initially, weight gains of dairy heifers were greater with the legume mixture compared to nitrogen fertilized orchardgrass. During the 1961 season, Ladino clover constituted less than 15% of the mixture; production was poor and heifers on nitrogen-fertilized orchardgrass gained more and substantially more animals were carried to the acre.

VERMONT

Title: STUDIES IN LOTUS SPECIES

Leader: A. Gershoy

Master's thesis studies conducted by graduate student Elaine S. Barnes indicate rather precise nutritional requirements for regenerative growth in vitro of florets, fragments of pedicels and, especially, immature embryos. The sequential stages of growth in vitro are: 1) callus formation, 2) endogenous root development above callus tissue (but not from it), 3) a greatly delayed formation of leaves followed by the development of an apical stem meristem. Test tube cultures have been successfully transferred to soil. The continued growth of immature embryos in situ, (i.e. within ovule still attached to placenta of the pistil) demand even more precise requirements, that is, such adjuncts as kinetin, extracts of coconut milk and the like. Thus far in the studies enlargement of pistil and ovule and a limited additional growth of immature embryos have been recorded. Vigorous, complex species hybrids have been synthesized involving L. corniculatus, 4 x L. uliginosus, 4 x L. tenuis, 4 x L. japonicus. These have an extended flowering period, produce pollen abundantly but tend to abort embryos in the pro-embryo stage. Studies of in situ embryo growth in vitro are being conducted. Meiotic studies in pollen mother cells show the presence of a variably small number of lagging univalents and the absence of multivalent associations.

Title: THE INFLUENCE OF THERMOPERIODS AND LIGHT ENERGY ON THE PRODUCTION OF THE SEXUAL STAGE OF SCLEROTINIA TRIFOLIORUM

Leader: Thomas J. Sproston, Jr.

An attempt was made to discover an action spectrum for the pigment receiving the light energy in apothecial fundaments of Sclerotinia trifoliorum by using an Eppley thermopile. A partial spectrum was obtained. Work is continuing (1960 Annual Report, page 119). Isolations have been made from fundaments using silica jell columns. A product has been obtained in crystalline form and partially identified as one of the Q-enzymes. Time will tell if this is the pigment that is receiving the light energy or playing some other part in the maturation of apothecia.

Title: FORAGE CROP INSECTS, THEIR RELATIVE IMPORTANCE AND CONTROL

Leader: George B. MacCollom

Studies continued on the correlation of Arthropod populations and amount of birdsfoot trefoil seed yielded on twelve locations. Temperature, humidity, insecticidal treatment, and spring burning of fields were measured for effect on population densities. These studies confirmed investigations in 1959 (1960 Annual Report, page 118) that there is a significant correlation between Mirid populations and the amount of seed yielded.

The lesser clover leaf weevil, Hypera nigrirostris (Fab.) was found feeding for the first time on birdsfoot trefoil, Lotus corniculatus. Severe injury to developing buds was observed on two commercial fields.

Title: STUDIES IN TRIFOLIUM MEDIUM L.

Leader: A Gershoy, Department of Botany

Cooperator - T. R. Flanagan, Department of Agronomy

Investigations in species-hybridization, involving Trifolium medium L. and other clover species, substantiate earlier findings reported here. Reciprocal cross-pollinations between zig-zag clover and diploid and tetraploid red clover and alsike clover have been unsuccessful; failure of normal pollen-tube growth has been observed to be a limiting factor. Similarly, negative results were obtained in attempts to cross reciprocally T. medium with F₃ allopolyploid T. pratensis x T. diffusum (sent by courtesy of Dr. H. Taylor of Kentucky).

Title: AGRONOMIC EVALUATION OF NEW EXPERIMENTAL LINES AND HYBRIDS OF BIRDSFOOT TREFOIL

Leaders: T. R. Flanagan and F. Laing

A. Seventh cycle of selection of hybrids of L. corniculatus and L. tenuis 4 X was completed. Several new selections were included in the observations. Several L. uliginosis combinations look most promising.

B. Second-year harvests were made for selected hybrid lines previously established in replicated plots at two locations. Several lines maintained yield levels significantly greater than Mansfield or Viking. Seed increase of highest yielding lines is being continued.

Title: SHEEP GRAZING TRIALS WITH BIRDSFOOT TREFOIL

Leaders: G. M. Wood and K. E. Varney

Under the conditions of this experiment (1960 Annual Report, page 120) Empire in the second year of grazing by sheep was found to be superior to the other trefoils included in the test. Because of the reluctance of the cooperating farmer to force the animals to graze closely, under the so-called severe treatment, no differences between the severe and rotational treatments were obtained. Polyploid narrowleaf trefoil was second to Empire and superior to 2n narrowleaf, Mansfield and hybrid (L. corniculatus, Europ. X 2n L. tenuis).

Title: NITROGEN STUDIES WITH GRASS

Leader: K. E. Varney

A preliminary study of the effects of split applications of nitrogen on yield of grass was initiated in 1961. Replicated plots were laid out in established fields of pure grass (a mixture of brome, timothy, and Kentucky bluegrass in one field; a pure brome stand in the second). First-year results are as follows:

Lbs. N applied		Yield - tons DM/acre*		
Spring (May 4)	After 1st cut (June 25)	1st harvest	2nd harvest	Season total
75	75	3.46	1.74	5.20
100	50	3.41	1.65	5.06
50	50	3.38	1.64	5.02
50	100	3.26	1.72	4.98
100	0	3.41	1.46	4.87
50	0	3.26	1.31	4.57
0	100	2.71	1.62	4.33
0	50	2.73	1.60	4.33
LSD	.05			0.37
LSD	.01			0.50
C.V.	%			6.4

*Ave. 2 locations, 4 reps.

WEST VIRGINIA

Title: FACTORS INFLUENCING LOSSES FROM ROOT ROTS OF FORAGE LEGUMES

Leaders: Edward S. Elliott and Robert E. Baldwin

The effect of various degrees of stand thinning, such as caused by diseases and insects, on the total yield of red clover plantings is being investigated. Information on this thinning of red clover, as it relates to competition between plants and their total growth should indicate at what point it is economically feasible to attempt disease control.

A study is being made of the organisms involved in red clover root rot problems. This work has been confined primarily to fungi of the genus Fusarium and to the relationship of nematodes to root problems. The relationship of various soil characteristics to the presence of these organisms and the root rot problem is being surveyed.

Title: DISEASES OF FORAGE GRASSES

Leader: Edward S. Elliott

The effects of a few fertilization practices on the development of diseases in Kentucky bluegrass are being studied. Other pasture grasses will be included in this work in 1962.

A considerable number of local selections of Kentucky bluegrass and also introductions from Europe are being screened for resistance to two rusts and Helminthosporium vagans and for other desirable characteristics. The best of these will be compared to native types to find if they are of value for pasture use.

Title: THE PERFORMANCE OF SEVERAL ALFALFA VARIETIES GROWN UNDER DIFFERENT CLIMATIC CONDITIONS, WITH EMPHASIS ON THE INFLUENCE OF FALL CUTTING

Leaders: G. A. Jung and W. T. Carlson

Studies of the performance and persistence of six alfalfa varieties grown at eight locations under four fall cutting managements were continued as in 1960, (1960 Annual Report, page 121).

A statistical analysis of this year's data indicates significant differences owing to: (1) location, (2) varieties, (3) location x variety interaction, (4) location x management interaction, and (5) variety x management interaction.

Since most alfalfa fall cutting recommendations are made without regard to variety, the significant interaction between varieties and fall cutting management which has been observed for two consecutive years would seem to be an important observation.

Over 50% of the yield (alfalfa + grass) observations (including all varieties, management, and locations) exceeded 5.5 T/A (15% moisture). The range in yields of the alfalfa fraction was from 1.81 T/A to 7.76 T/A. The maximum difference obtained between varieties at a location was 2.25 T/A, and the maximum difference obtained between cutting managements at a location was 1.15 T/A.

Title: EVALUATION OF SUDANGRASS FOR PASTURE

Leaders: G. A. Jung and W. T. Carlson

Twenty-one Sudangrass and Sudangrass hybrid varieties were studied at five locations using three levels of nitrogen at three locations and one level of nitrogen at the other two locations. The plots were harvested when the Sudangrass reached three feet in height.

The results indicate significant differences were obtained for (1) varieties, (2) locations, (3) nitrogen fertilization, (4) location x variety interaction and (5) variety x nitrogen interaction. Prussic acid studies on the twenty-one varieties indicated that there was a range in content of prussic acid from 5 ppm to 2300 ppm (based on dry wt.). Seasonal averages of the prussic acid content (all varieties) showed an 89% increase of prussic acid content with a 50-lb./A application of nitrogen and a 163% increase with a 200-lb./A application of nitrogen over the prussic acid content of the varieties not fertilized with nitrogen.

Yields ranged from 1.30 T/A to 5.24 T/A. A 50-lb./A application of nitrogen gave an average yield increase of 17% and a 200-lb./A application of nitrogen a 58% increase over the unfertilized varieties. Many of the Sudangrass hybrids outyielded Sudangrass varieties such as Piper and Tift. This would appear to be a significant fact since Piper was our highest yielding Sudangrass variety in a number of previous trials.

Title: RATE OF APPLICATION OF K FERTILIZER IN RELATION TO YIELD
AND LONGEVITY OF ALFALFA STANDS

Leaders: C. D. Reese and G. G. Pohlman

Objectives: The objectives of the study are: (1) To determine the effect of total available potassium, present in soils or applied as potassium fertilizer, on the yield and longevity of alfalfa stands, (2) to determine the relationship between potassium content of alfalfa at various harvests and yield and longevity, (3) to measure potassium removal by alfalfa from soils having different levels of available potassium.

Summary: First-year yield data were obtained in 1961 from experimental plots at Reymann Memorial Farm, Ohio Valley Experiment Station, Reedsville Experiment Station, and the Agronomy farm. Plant samples from these locations have been prepared for chemical analyses. Soil samples and stand counts were taken from demonstration plots in 10 counties. The soil samples were analyzed for pH, available P_2O_5 and K_2O . A modified Truog method was used to determine available P_2O_5 and K_2O . Because 1961 was the first cutting year for the four experimental plot locations, no conclusions can be drawn from the data obtained. The demonstration plots which were sampled seem to show a positive relationship between available potassium and longevity of stands.

Title: SUDANGRASS FERTILITY AND CUTTING MANAGEMENT TRIAL

Leaders: G. A. Jung and Burkey Lilly

Five levels of nitrogen (0, 50, 100, 200, 300 lb./A) fertilization and five cutting managements (12", 18", 24", heads emerging, full bloom) were imposed on Piper Sudangrass as in 1960 (1960 Annual Report, page 120). The cutting managements were imposed on all aftermath cuttings, the first cutting taken as the heads emerged.

This year's results indicate significant differences due to 1) rate of nitrogen fertilization and 2) physiological stage of growth when cut.

The average yield for the cutting managements grown under the lowest level of nitrogen (0 lb./A) was 2.23 T/A while the average yield for the cutting management grown under the highest level of nitrogen (300 lb./A) was 4.09 T/A. The average yield for the nitrogen levels cut when 12" high was 2.43 T/A and was 4.04 T/A when cut at the full-bloom stage. The lowest producing treatment (0 lb. N/A, cut 12") yielded 1.73 T/A and the highest producing treatment (300 lb. N/A, cut full-bloom stage) yielded 5.50 T/A.

The results in 1960 and 1961 show that Sudangrass should be clipped or grazed before taking a cutting for silage if maximum yields are desired. Tillering after cutting the first growth resulted in greater yields of the second growth.

Low levels of prussic acid were found under all cutting managements and all levels of nitrogen fertilization.

Title: PHYSIOLOGICAL AND BIOCHEMICAL STUDIES OF COLD RESISTANCE IN PLANTS

Leaders: G. A. Jung, D. C. Shelton, and S. C. Shih

Cold resistance studies on a hardy and a non-hardy variety of alfalfa sprayed with certain purines and pyrimidines were initiated during the fall of 1961. The objectives of the experiment are to determine the effect of the purine and pyrimidine treatments on cold resistance, nitrogen metabolism, and respiration.

Cold resistance determinations as determined by Dexter's method indicated that certain metabolites stimulated and others inhibited cold resistance development during the fall and early winter of 1961.

Title: BIOCHEMICAL STUDIES ON COLD RESISTANCE OF ALFALFA

Leaders: G. A. Jung and W. T. Carlson

Sampling was continued as in 1960 (1960 Annual Report, page 122).

Cold resistance measurements indicated that the order of cold resistance increased from stele to cortex to crown to buds. It was observed that when the cold resistance measurements of the various tissues were added together in the proportional amounts by weight in which each tissue composed the entire sample, the summation equalled the cold resistance measurement obtained for the intact tissues. Therefore, separation of the tissues did not appear to influence the cold resistance measurement.

Title: GRAIN REPLACEMENT VALUES OF HAYS CUT AT VARIOUS DATES

Leaders: A. H. Rakes, R. L. Reid and I. D. Porterfield

An alfalfa-grass mixture and a pure stand of alfalfa were subdivided, cut and field-cured during three different periods: Plot A, May 15-19; Plot B, May 29-June 2; and Plot C, June 12-16. Appreciable weather damage occurred in Plots A and B of the second field. The hays were analyzed as a part of the West Virginia Forage Testing Program. Digestible energy values were estimated using an in vitro procedure and digestible protein by the formula ($DP = 0.929 \text{ (C.P.)} - 3.48$). Six groups of five cows each, allotted according to age, stage of lactation, and body weight, were used in two 20-day lactation trials to compare the feeding value of the hays. During a six-day preliminary period, the voluntary intake levels of the hays were determined. Grain mixtures were used to adjust the total protein and energy intake of the different groups to approximately the same level. Data obtained from the analyses and the lactation trials are tabulated below:

	Field 1 Plot A	Field 1 Plot B	Field 1 Plot C	Field 2 Plot A	Field 2 Plot B	Field 2 Plot C
Estimated digestible Energy (Therms/pound)	1.29	1.16	1.09	1.23	1.28	1.18
Estimated digestible Protein (percent)	15.41	13.48	9.63	16.00	16.13	17.51
Voluntary intake (Pounds/100# body wt.)	2.3	2.0	1.6	1.9	2.0	1.8
Portion of energy supplied by hay (Percent)	61.2	48.8	36.7	48.6	55.9	45.6

Milk production was not significantly altered by the different feeding treatments ($P < .05$).

Title: A COMPARISON OF THREE METHODS OF FEEDING HAY TO YEARLING CATTLE WINTERED IN THE OPEN

Leaders: C. J. Cunningham and G. C. Anderson

Forty-one head of long yearling heifers and steers weighing about 650 lb. were divided as equally as possible into three groups and wintered in eight-acre traps with a southern exposure which were protected from prevailing winds by a mountain range. The cattle were fed a coarse first cutting mixed hay (clover 50%, orchardgrass 20%, brome 20%, weeds 10%) and had free access to water and a 50-50 mixture of salt and steamed bone meal. Initial and final weights were the average of three appropriate consecutive weighings. Lot 1 cattle (13 head, 4 steers, 9 heifers) were fed about 2 lb. of hay per 100 lb. of body weight once daily in a rack, and Lot 2 cattle (14 head, 5 steers and 9 heifers) received hay on the same basis but it was fed on the ground. Lot 3 cattle (14 head, 5 steers, 9 heifers) consumed hay without restriction from a rack which was replenished once each week. At the end of the 87-day trial (December 8/60 - March 15/61 figures for the average hay consumption and weight change per animal were: Lot 1, 1300 lb., 19 lb. loss; Lot 2, 1200 lb., 36 lb. loss; and Lot 3, 1957 lb., 22 lb. gain. Fifty-man-hours of labor were required to feed Lots 1 and 2 while only 15 hours of labor were required to feed Lot 3. The removal and scattering of manure accumulated around the hay racks required 4-man and 6-machine hours for Lot 1, and 7-man and 10-machine hours for Lot 3.

Title: RUMEN BIOPSY TECHNIQUE AND ITS APPLICATION

Leaders: L. Dozsa, G. C. Anderson and G. A. McLaren

Recent findings suggest that the rumen mucosa may be of considerable metabolic significance. Further the character and possible functions of this tissue may be influenced by the physical nature and composition of the rumen ingesta. Definitive studies of these possible functions and their interrelationships would be enhanced if suitable amounts of tissue could be obtained from the living animal. A series of biopsies were performed on a fistulated sheep using a uterine biopsy forceps. A rumen wall area about 10 inches in diameter opposite the fistula could be sampled satisfactorily. A malleable type forceps which is being developed should permit an extension of the sampling area. A slight inappetance was observed after the first biopsy. Subsequent biopsies did not appear to affect the lamb. Fifty biopsy samples were obtained over a 224-day period during which time three types of roughage, alfalfa pellets and a semi-purified high-urea ration were fed. Histological study of biopsy material showed definite structural changes which could be associated with the ration fed. The applicability of the technique for obtaining biochemical assay material was studied. A single biopsy yielded from 25-50 mg of tissue. The metabolic activity of biopsy material in terms of glutamic dehydrogenase was comparable to that of similar tissue obtained from freshly slaughtered lambs.

USEFUL TECHNIQUES

U. S. REGIONAL PASTURE RESEARCH LABORATORY

A Rapid Technique for Study of Pollen Tubes in Smeared Styles

Martin in Stain Tech. 34:125-128, 1959, outlined a procedure for examining pollen tubes in fertilized tomato styles. The position of pollen tubes is indicated by fluorescence under microscope with dark field ultraviolet illumination. The technique which was tried successfully on several clover species and on alfalfa may prove to be helpful in selecting clones with rapid pollen tube growth.

VERMONT AGRICULTURAL EXPERIMENT STATION

Rooting of softwood cuttings of Zigzag (T. medium) and red clover was facilitated with the use of a modified mist chamber. Terminal portions of stems were first dipped in 0.1% indolebutyric acid powder or aqueous solution, then placed on a glass or plastic film chamber intermittently sprayed with mist from common oil burner nozzles connected to the water line via a time clock and solenoid valve. Rooting mediums of common sand or bench gravel were as efficient as vermiculite, and more so than sphagnum moss or perlite. Good rooting occurred within 2-3 weeks on 50 to 100% of the cuttings depending on clones used.

LIST OF PUBLICATIONS

- Anonymous. The nutritive evaluation of brome grass hay grown under different levels of nitrogen fertilization and harvested at different stages of maturity. N.H. Agr. Exp. Sta. Bul. 472. 1962.
- Arnold, E. L. Inducing feed flow from bulk bins. Vermont Agr. Exp. Sta. Bul. 621. 1961.
- Bache, C. A., George G. Gyrisco, S. N. Fertig, E. W. Huddleston, D. J. Lisk, F. H. Fox, G. W. Trimberger and R. F. Holland. Effects of feeding low levels of heptachlor epoxide to dairy cows on residues and off-flavor in milk. J. Agr. & Food Chem. 8:408-9. 1960.
- Bartlett, R. J. Iron oxidation proximate to plant roots. Soil Sci. 92:372-379. 1961.
- Begg, J. E. and M. J. Wright. Growth and development of leaves from intercalary meristems in the Gramineae. Agron. Abs., 58. 1961.
- Boehle, John Jr., Louis T. Kardos and John B. Washko. Effect of irrigation and deep fertilization on yields and root distribution of selected forage crops. Agron. Jour. 53:153-158. 1961.
- Brown, B. A. Fertilizer experiments with alfalfa (1915-1960). Storrs (Conn.) Agr. Exp. Sta. Bul. 363. 1961.
- Buckner, Robert C, Helen D. Hill and Paul B. Burrus, Jr. Some characteristics of perennial and annual ryegrass x tall fescue hybrids and of the amphidiploid progenies of annual ryegrass x tall fescue. Crop Sci. 1:75-80. 1961.
- Burdick, D. and J. T. Sullivan. Rate of hydrolysis of forage hemicellulose as related to digestibility. Am. Soc. Animal Prod., No. Atlantic Section Proc. III(8):1-4. 1961.
- Carnahan, H. L. and Helen D. Hill. Cytology and genetics of forage grasses. Bot. Rev. 27:1-162. 1961.
- Carncross, John W. Capital requirements and income expenses on 23 Hunterdon County New Jersey dairy farms. Dept. of Agr. Econ., A. E. 260 Rutgers Univ.
- _____. Larger dairy herds have higher net incomes. Dept. of Agr. Econ., A. E. 273, Rutgers Univ.
- _____. The dairy farm business for 15 high producing herds. Dept. of Agr. Econ., Unnumbered Mimeo., Rutgers Univ.
- Chalupa, W. V., J. L. Cason and B. R. Baumgardt. Nutritive value of reed canarygrass as hay when grown with various nitrogen levels. J. Animal Sci. 44:874. 1961.

- Chen, Tseh-An, R. A. Kilpatrick and A. E. Rich. Sterile culture techniques as tools in plant nematology research. *Phytopath.* 51:799-800. 1961.
- Cowett, E. R. Crown bud initiation and subsequent shoot development of alfalfa (Medicago sativa L.) as affected by environmental and physiological factors. Ph.D. Thesis. Rutgers University. 1961.
- Cunningham, L. C. Commercial dairy farming---Plateau Region, New York, 1957-58. Cornell Univ. Agr. Exp. Bul. 966, 1961.
- Day, S. W. and M. J. Wright. The influence of partial drying before storage on the organic acid content of alfalfa silage. Cornell Agronomy Mimeo No. 61-5. 1961.
- Downes, Ross W. A study of variation in height and maturity in timothy, Phleum pratense L. Ph.D. Thesis. Cornell University. 1961.
- Duell, R. W. Better pastures for horses and ponies. New Jersey Agr. Exp. Sta. Extension Bul. 350. 1961.
- _____. Bermudagrass has multiple-leaved nodes. *Crop Science* 1:230-231. 1961.
- _____. Horse pasture maintenance. The New Jersey Thoroughbred, Stallion Edition, Vol. XIV, No. 1. 1961.
- _____. Horse pastures are different. Pony of the Americas Club Yearbook (Mason City, Iowa). pp. 21-23. 1961.
- Dunn, G. M. and R. A. Kilpatrick. Performance of forage varieties and strains in New Hampshire, 1955-60. N.H. Agr. Exp. Sta. Bul. 470. 1961.
- Elliott, Kendall C. Electric control panel for an automatic silage unloading and feeding system. M.S. Thesis. Univ. of West Virginia. 1961.
- Elliott, K. C. Multi-purpose wagon. West Virginia Agr. Exp. Sta. Current Report 29, March 1961.
- Fellows, I. F. Forage production and use on Connecticut dairy farms. Storrs Agr. Exp. Sta. Bul. No. 352. 1960.
- _____. and N. E. Engel. Economic effects of alternative organizations on large dairy farms. Storrs Agr. Exp. Sta. Bul. No. 354. 1960.
- Flanagan, T. R. and R. J. Bartlett. Soil compaction associated with alternating green and brown stripes on turf. *Agron. J.* 53:404-405. 1961.

- Forsythe, H. Y., Jr. and George G. Gyrisco. Determinining the appropriate transformation of data from insect control experiments for use in the analysis of variance. J. Econ. Ent. 54:859-61. 1961.
- _____, C. S. Koehler and George G. Gyrisco. Long-term effectiveness of soil insecticides on the alfalfa snout beetle larva. J. Econ. Ent. 54:601. 1961.
- Graham, J. H. and E. S. Luttrell. Species of Leptosphaerulina on forage plants. Phytopath. 51:680-693. 1961.
- _____, W. G. Sprague and K. E. Zeiders. Effect of management and pesticides on persistence of Ladino white clover. Agron. J. 53:356-357. 1961.
- Gyrisco, George G. Latest recommendations on spittlebug control. American Agriculturist 157(9):8,17. 1960.
- _____, and E. W. Huddleston. The persistence of aldrin, dieldrin and endrin residues on fresh forage and on hay under various conditions of curing. J. Econ. Ent. 54:718-20. 1961.
- _____, D. J. Lisk, S. N. Fertig, E. W. Huddleston, F. H. Fox, R. F. Holland and G. W. Trimmerger. The effects of feeding high levels of Sevin on residues, flavor and odor of the milk of dairy cattle. J. Agr. and Food Chem. 8:409-10. 1960.
- _____, and C. S. Koehler. The latest recommendations on the control of the alfalfa weevil. American Agriculturist 157(10):6,25. 1960.
- Haenlein, G. F. W. and C. R. Richards. Nutritive value of amercane silage for milking cows, sheep and rabbits. J. Dairy Sci. 44:1175. 1961. (Abs.)
- Haller, Thomas. Opportunities for economically increasing forage production under restricted resource conditions in Connecticut. M.S. Thesis. Univ. of Connecticut. 1961.
- Hanson, A. A. and F. V. Juska. Winter root activity in Kentucky bluegrass (Poa pratensis L.). Agron. J. 53:372-374. 1961.
- Hanson, C. H. Registration of varieties and strains of alfalfa. Agron. J. 53:400. 1961.
- _____, E. L. Sorensen, C. P. Wilsie, H. L. Carnahan, M. W. Pedersen, W. R. Kehr and J. W. Dudley. Variation in protein and crude fiber content of alfalfa as related to variety, location, cutting and year effects. Agron. Abstr. 1961:52.
- Haven, R. C., B. R. Poulton and M. J. Anderson. The effect of varying re-growth intervals and initial harvest dates on the nutritive value of aftermath timothy hay. J. Dairy Sci. Abs., 1961.

- Hollowell, E. A. Registration of varieties of red clover. Agron. J. 53:403. 1961.
- _____. Registration of varieties of sweet clovers. II. Agron. J. 53:404. 1961.
- Huddleston, E. W. and George G. Gyrisco. Residues of phosdrin on alfalfa and its effectiveness on the insect complex. J. Econ. Ent. 54:209-10. 1961.
- _____ and _____. Residues of Sevin and 1-naphthol from aerial applications of Sevin in oil. J. Econ. Ent. 53:484. 1960.
- _____, _____ and D. J. Lisk. DDT residues on New York dairy farms following the gypsy moth eradication program. J. Econ. Ent. 53:1019-21. 1960.
- _____, K. H. Thompson, George G. Gyrisco, D. J. Lisk, T. W. Kerr, Jr. and C. E. Olney. Sampling experimental plots of alfalfa for insecticide residues. J. Econ. Ent. 53:1078-80. 1960.
- Hunt, R. T. The effect of plant species, maturity, and fertilization on the energy value and composition of forages for sheep. M.S. Thesis. Rutgers Univ. 1961.
- Jung, G. A. and Dale Smith. Trends of cold resistance and chemical changes over winter in the roots and crowns of alfalfa and medium red clover. Agron. J. 53:359-366. 1961.
- Juska, F. V. and A. A. Hanson. Effects of interval and height of mowing on growth of Merion and Common Kentucky bluegrass (Poa pratensis L.). Agron. J. 53:385-388. 1961.
- Jutras, M. W. The responses of five forage grasses to various cutting managements. M.S. Thesis. Univ. of Connecticut. 1961.
- Kearney, P. C. A study of the sources and control of nutritional losses occurring during the harvesting and storage of hay and silage. Ph.D. Thesis. Cornell Univ. 1961.
- Kilpatrick, R. A. Fungi associated with larvae of Sitona species. Phytopath. 51:640-641. 1961.
- _____ and G. M. Dunn. Fungi and insects associated with deterioration of white clover taproots. Crop Sci. 1:147-149. 1961.
- Kleis, R. W. Farmstead engineering--hay handling systems. Hoard's Dairyman, 106(17), Sept. 10, 1961.

- Kleis, R. W. Farmstead engineering--silage handling systems. Hoard's Dairyman 106(18), Sept. 25, 1961.
- _____. Materials handling--methods and labor requirements. Agr. Engr. Transactions 3(2). 1960.
- Koehler, C. S., K. D. Fezer, H. H. Neunzig and George G. Gyrisco. The economic importance of the clover root borer. J. Econ. Ent. 54: 631-5. 1961.
- _____ and George G. Gyrisco. Responses of the alfalfa weevil, Hypera postica, to controlled environments. J. Econ. Ent. 54:625-7. 1961.
- _____, _____, L. D. Newsom and H. H. Schwardt. Biology and control of the clover root borer, Hylastinus obscurus (Marsham). Cornell Univ. Agr. Exp. Sta. Memoir 376:1-36. 1961.
- Marrese, R. J., R. W. Duell and M. A. Sprague. Need information on chemistry of phytin. New Jersey Agr. 43:7. 1961.
- _____, _____ and _____. A comparison of three current methods for the analysis of phytin phosphorous. Crop Science 1:80-81. 1961.
- Marriott, L. F. Nitrogen fertilization of perennial grasses. Penna. Agr. Exp. Sta. Bul. 688. 1961.
- Mays, D. A. and J. B. Washko. Cutting and grazing management for Sudangrass and pearl millet. Penna. Agr. Expt. Sta. Bul. 682. 1961.
- _____, _____ and J. W. Bratzler. Tall or dwarf corn silage? Crops and Soils 13:16-17. 1961.
- McKee, Guy W. Alfalfas observably different. Science for the Farmer (The Penn. State Univ.) VII:6. 1961.
- Mosher, Henry L. Reaction forces of restrained forage wafers. M.S. Thesis. The Pennsylvania State Univ. 1961.
- Peters, R. A. Legume establishment as related to the presence or absence of an oat companion crop. Agron. J. 53:195-198. 1961.
- _____ and H. C. Yokum. Progress report on a study of the germination and growth of yellow foxtail (Setaria glauca (L.) Beauv.). Proceedings 15th Northeastern Weed Control Conference. 1961.
- Poinar, George O., Jr. and George G. Gyrisco. Effects of light, temperature and relative humidity on the diel behavior of the alfalfa weevil, Hypera postica. J. Econ. Ent. 53:675-7. 1960.
- Poulton, B. R., R. C. Haven, H. E. Foss and T. N. Mellin. A comparison of the results of several in vitro forage evaluation techniques with in vivo values. J. Dairy Sci. Abs. 1961.

- Richards, C. R., J. D. Connolly, G. F. W. Haenlein, Fleeger, J. L. and H. G. Weaver. Comparison of the digestible dry matter harvest from orchardgrass and brome grass pastures by grazing cows. J. Dairy Sci. 44:340-345. 1961.
- Ridgway, R. L. and George G. Gyrisco. Evaluation of insecticides for control of the tarnished plantbug on birdsfoot trefoil. J. Econ. Ent. 53: 690-1. 1960.
- _____ and _____. Studies of the biology of the tarnished plantbug, Lygus lineolaris. J. Econ. Ent. 53:1063-65. 1960.
- _____ and _____. Effect of temperature on the rate of development of Lygus lineolaris (Hemiptera:Miridae). Ann. Ent. Soc. America. 53:691-4. 1960.
- _____ and _____. Control of the tarnished plantbug, Lygus lineolaris on birdsfoot trefoil grown for seed. J. Econ. Ent. 54:244-6. 1961.
- Sayers, Earl R. The relationship of chromosome number and pollen stainability to seed-set in Medicago sativa L., variety Narragansett. M.S. Thesis. Cornell Univ. 1961.
- Schneider, E. C. "Push-button" reaches stanchion feeding. Dairymen's League News. 45(6):3,10,19. 1961.
- _____. Conveyor feeding system for dairy cows in stanchions and in loose housing. Progress Rept. No. 4, Bale metering. Vermont Agr. Exp. Sta. Bul. 622, 1961.
- Shorey, H. H., R. H. Burrage and George G. Gyrisco. The relationship between several environmental factors and the density of European chafer larvae in permanent pasture sod. Ecology 41:253-8. 1960.
- _____ and George G. Gyrisco. Effects of soil temperature and moisture on the vertical distribution of European chafer larvae. Ann. of Ent. Soc. America 53:666-70. 1960.
- Singley, M. E. Dynamic structures--buildings that work. Implement and Tractor. March 15, 1961.
- Skaland, Nils. Effects of cutting management and nitrogen fertilization on the productivity and persistence of timothy (Phleum pratense). M.S. Thesis. Univ. of Rhode Island. 1961.
- Sprague, Vance G. Organic food reserves, regrowth and winter hardiness of defoliated grasses and legumes. Agron. Abstr. 1961.
- Starling, J. L. Cytogenetic study of interspecific hybrids between Phalaris arundinacea and P. tuberosa. Crop Science 1:107-111. 1961.

- Stewart, Larry E. The design, construction, and testing of a prefabricated portable box silo. M.S. Thesis. Univ. of West Virginia. 1961.
- Stoker, R. D., J. L. Evans, M. C. Stillions, W. V. Chalupa and C. H. Ramage. The digestibility of common timothy hays grown with different levels of nitrogen fertilization. J. Dairy Sci. 44:1206. Abs. 1961.
- Sullivan, J. T. and D. Burdick. The problem of predicting digestibility from chemical composition. Presented at Conference on Rumen Function, Chicago, Ill., November 30, 1961.
- _____, E. S. Titlar and T. V. Hershberger. Chemical composition of non-heading orchardgrass plants. Am. Soc. Animal Prod., No. Atlantic Section Proc. III(7):1-3. 1961.
- Van Duyne, Daniel A. Air flow resistance of baled alfalfa and clover hay. M.S. Thesis. The Pennsylvania State Univ. 1961.
- Van Soest, P. J. The use of detergents in the analysis of forages and determination of the effects of heat-drying upon proteins. J. Dairy Sci. 44:1177. Abs. 1961.
- Washko, J. B. Grass or legumes for forage--take your pick. Plant Food Review. 7(4):2-6. Winter 1961-62.
- _____. Summer annuals--good pasture insurance. New Holland Grassland News. 7(1):8. 1961.
- White, H. E. A study of the regrowth of Sudangrass and millet cut at various stubble heights and stages of development. M.S. Thesis. Rutgers Univ. 1961.
- Whitney, L. F. Hay losses from components of balers and choppers. Paper presented at ASAE Annual Meeting, Ames, Iowa, 1961. Mass. Agr. Exp. Sta. Paper 1302.
- Withers, R. V. Legume content and management practices on hay meadows, Otsego County, New York. Thesis. Cornell Univ. 1959.
- Wood, G. M. Relation of temperature to quantity of forage consumed by chickens on range. Poultry Sci. 40:1134-1135. 1961.
- Wysong, John W. Costs, returns and profitability of artificial hay drying on northeastern dairy farms. Md. Agr. Exp. Sta. Bul. 471. 1961.
- Yokum, H. C., M. W. Jutras and R. A. Peters. Preliminary investigations of a germination and growth inhibitor produced by yellow foxtail (Setaria glauca (L.) Beauv.). Proceedings 15th Northeastern Weed Control Conference. 1961.



